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FURTHER RESEARCH ON SPEEDED SPEECH AS AN EDUCATIONAL MEDIUM.
FINAL REPORT, PARTS 1-5, JULY 1965--SEPTEMBER 1967.
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DESCRIPTORS- *SPEECH COMPRESSION, LISTENING HABITS, *LISTENING SKILLS, *LISTENING COMPREHENSION, *COLLEGE STUDENTS, TABLES (DATA), READING TESTS, RESEARCH DESIGN, *AUDITORY TRAINING, RETENTION STUDIES, SILVER SPRING,

UNDER TWO GRANTS FROM THE NEW EDUCATIONAL MEDIA BRANCH OF THE OFFICE OF EDUCATION, RESEARCH CONDUCTED AT THE AMERICAN INSTITUTES FOR RESEARCH FROM 1963 THROUGH 1967 EXAMINED MAJOR VARIABLES IN LISTENING COMPREHENSION WHEN COLLEGE-AGE STUDENTS ARE EXPOSED TO RATE-CONTROLLED SPEECH. THE TECHNIQUE USED TO ALTER THE RATE OF PRESENTATION OF TAPE-RECORDED SPEECH IS AN INNOVATION WHICH PERMITS THE SPEED OF SPEECH TO BE ALTERED INDEPENDENTLY OF PITCH. COLLEGE STUDENTS WERE TESTED IN A NUMBER OF EXPERIMENTS USING NOVELS AS PRACTICE LISTENING MATERIAL AND HISTORICAL PASSAGES AS TEST MATERIAL, WITH LESS COMPLETE EXAMINATION OF PSYCHOLOGICAL AND GEOLOGICAL MATERIALS. VARIABLES WERE GROUPED INTO THREE AREAS--(1) STIMULUS VARIABLES (AMOUNT, DURATION, RATE, CONTENT, AND CONTINUITY OF EXPOSURE TO PRACTICE AND TEST LISTENING MATERIALS), (2) SITUATIONAL VARIABLES (LISTENING AIDS BEFORE AND DURING MATERIAL PRESENTATION, SELF-DETERMINATION OF RATE, MEASUREMENT OF RETENTION, AND USE OF COMPRESSED SPEECH AS A METHOD OF REVIEW), AND (3) LISTENER VARIABLES (INDIVIDUAL DIFFERENCES IN SEX, INTERCORRELATIONS BETWEEN LISTENING AND READING SCORES, AND GENERAL LANGUAGE ABILITY). THE RESULTS DEMONSTRATE THAT STUDENTS CAN LEARN TO COMPREHEND COLLEGE LEVEL MATERIAL AT BETTER THAN TWICE THE NORMAL RATE. SIGNIFICANT IMPROVEMENTS AT TWO AND ONE-HALF TIMES NORMAL CAN BE ACHIEVED WITH TEN HOURS OF PRACTICE. NEARLY ALL STUDENTS WERE RECEPTIVE TO THE USE OF COMPRESSED SPEECH IN THE EDUCATIONAL SETTING. (HM)

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U. S. DEPARTMENT OF
HEALTH, EDUCATION, AND WELFARE

Office of Education
Bureau of Research

FINAL REPORT

Project No. 5-0801
Grant No. OE-7-48-7670-267

FURTHER RESEARCH ON SPEEDED SPEECH AS AN EDUCATIONAL MEDIUM

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OFFICE OF EDUCATION

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September 1967

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Not least, we should like to thank the students of the University of Maryland and Georgetown University for acting as subjects in these studies.

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SUMMARY

This project was designed to examine major variables in listening comprehension when college age students were exposed to rate-controlled speech. The technique used to alter the rate of presentation of tape recorded speech is an innovation which permits the speed of speech to be altered independently of pitch. Such variables as amount, duration, rate, content, and continuity of exposure to listening materials have been examined; as well as the use of listening aids, self-determination of rate, retention of content and skill, and the use of compressed speech as a review technique. In general, the results have been encouraging. Students can learn to comprehend college level material at better than twice the normal rate. Significant improvements at two and one half times normal can be achieved with ten hours of practice. Nearly all students have been receptive to the idea of using compressed speech in the educational setting. Implications for its use include presenting information more rapidly, using it as a training device, and use as a research tool in which the temporal variable is altered while other variables are held constant.

FINAL REPORT

PART 1

Project No. 5-0801

Grant No. OE-7-48-7670-267

FURTHER RESEARCH ON SPEEDED SPEECH AS AN EDUCATIONAL MEDIUM

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FINAL REPORT

PART 1

Project No. 5-0801

Grant No. OE-7-48-7670-267

Further Research on Speeded Speech as an Educational Medium

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David B. Orr

American Institutes for Research

Silver Spring, Maryland

July 1965

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U. S. DEPARTMENT OF
HEALTH, EDUCATION, AND WELFARE

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Progress Report

Introduction:

This report describes the first major experiment in a series of experiments to be conducted under grant number OE-7-48-7670-267 beginning March, 1965 and extending through February, 1967. This research is an outgrowth of the experimentation conducted under grant number OE-7-48-7670-203 (3/63 - 1/65).

It had long been assumed that the speed at which a man thinks far exceeds the speed at which normal speech is produced. The speed of neural activity is far greater than that of gross motor responses necessary to speech. It followed that given both man's physiological sound discriminatory capacity and his cognitive abilities (as evidenced by his ability to read faster than speech) that he could listen and comprehend speech that was faster if only there were a way to produce it. With the advent of a technique for the time-compression of speech which speeds output without distorting pitch, interest in the measurement and training of speeded speech listening capacity, grew.

In earlier research by the investigators*, college freshmen and sophomores were exposed to 10-15 hours of practice listening material (recorded novels) at speeds ranging from 325 words per minute (wpm) to 475 wpm. Subjects were tested on historical passages and a standard reading test, before and after experimentation, and periodically during practice. The results of this research suggested the following:

1. Zero to three hours of exposure to rapid speech led to comprehension at 325 wpm (or approximately double normal speed) which was between 80% and 100% of comprehension at normal speed.

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* See Progress Reports for June 1964 and February 1965

2. Ten to 15 hours of exposure to rapid speech (325 wpm to 475 wpm) led to a significant improvement on a repeated passage at 475 wpm presented before and after the experiment as compared with a control group which received similar tests but did not receive practice.

3. Male subjects did not differ significantly from female subjects in their overall listening performance.

4. Practice periods which were uninterrupted for about one hour proved more efficacious as a training procedure than practice listening which was punctuated with three minute rest periods every 10 minutes.

The experiment discussed in the current report essentially replicated the first experiment with the alteration of one major independent variable. The practice material, instead of being presented at successively higher speeds from week to week (325 wpm to 475 wpm) was presented at the beginning, and throughout the experiment, at 425 wpm. This has been described as "high-speed" vs. "graduated" practice listening. The before and after, and periodic benchmark test passages, were presented at the same speeds, as in the first two experiments.

Experimental Design*

Eighteen male college students (freshmen and sophomores) were paid $1.50 per hour plus bonuses to participate in the experiment. Initial measures were taken of reading ability employing alternate forms of the Nelson-Denny Reading Test, of listening ability at normal recording speed (175 wpm), and at very high speed (475 wpm). Subjects were also required to fill out a biographical questionnaire, and were given a pure-tone audiometric screening test to eliminate any subjects with gross hearing defects.

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* See Appendix for Tables showing materials used and design.

Practice listening was begun in the next session. The novel, "Cheaper by the Dozen" was presented in three sessions during the first week's practice at 425 wpm. At the end of the week a benchmark test passage was given at 325 wpm. The second, third, and fourth week's procedure was similar in that a new novel was presented at 425 wpm each week, followed by a benchmark test passage at the end of each week. The latter were presented at successive speeds of 325 wpm, 375 wpm, 375 wpm, and 425 wpm, just as they were in the previous two experiments. At the end of the four weeks' training, the original high speed test passage was again presented at 475 wpm, and the alternate form of the Nelson-Denny Reading test was also administered to mark any change in reading performance. Finally a new test passage was presented at normal speed (175) and comprehension measured.

In addition to the above tests, quizzes were given during the fourth week of training on the listening practice material. At the end of the experiment a comprehensive debriefing questionnaire was administered to examine the subjective responses of the listeners.

Again, in all major respects the procedure for this experiment was identical with the preceding two, except that practice material was all presented at 425 wpm instead of 325 through 475 wpm.

Results

The main results of this experiment confirm that of previous experiments in that performance at 325 wpm at the end of a week's practice was not significantly different from that at normal speed. (All scores were corrected for chance.) The mean score at 325 wpm was 108.5% of the mean score at 175 wpm*. (Table 1 shows the mean

---

* The percentage of normal speed score was obtained individually for each subject based on his own normal speed score; then these percentages were averaged for all subjects.

TABLE 1

(Mean Scores and Mean Scores as Percentages
of Normal (175 wpm) Speed Scores)
(All Scores Corrected for Chance)

	Experimental Groups				Control Group	
Test	High-Speed (Spring 1965)		Graduated (Spring 1964)		(Spring - 1964)	
Speed (wpm)	Mean	Mean % of Normal[a]	Mean	Mean % of Normal[a]	Mean	Mean % of Normal[a]
	N=18		N=16		N=16	
175[b]	13.8	100.0	15.7	100.0	17.4	100.0
475(1st)[b]	3.5	25.7	4.2	28.1	6.2	36.2
325	13.2	108.5	14.1	87.0	13.9	83.5
375(1st)	11.4	83.7	13.6	88.0	12.9	73.7
375(2nd)	11.6	84.9	13.6	88.3	13.1	75.0
425	8.6	70.6	12.2	79.4	8.6	50.0
475(2nd)	6.8	51.0	8.8	60.2	6.8	39.6

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[a] This column represents the mean of individual comparisons of 325 wpm with normal speed performance

[b] Prior to training (all other scores after training)

scores for the high-speed group as well as those for the graduated practice and control groups of Spring 1964.) The other major hypothesis that performance on a repeated passage at 475 wpm at the end of the experiment would be significantly better than that before training was also confirmed (at the .01 level). Table 2 shows various mean comparisons for the high speed group. The increase in mean score between the pre- and post- administration of the passage at 475 wpm was also significantly greater than that of the control group run in the spring of 1964 (at the .05 level of probability based on a Dunnett test). Performance at 425 wpm at the end of the experiment was approximately 71% of normal speed performance as compared with 50% for the original control group. This difference is also significant at the .05 level. The major hypothesis that performance on speeded speech with training can be improved with practice has been reaffirmed. (See Appendix for individual scores of group means).

With regard to whether or not this procedure, namely, presenting speeded speech practice at one high speed (425 wpm) throughout the experiment, is more or less efficacious than presentation at graduated speeds (from 325 wpm to 475 wpm) under the same conditions of uninterrupted practice sessions, subjects in the high speed practice experiment rose from a mean score on the pre-experimental presentation at 475 wpm, which was 25.7% of normal speed comprehension to a mean score on the post-experimental presentation, which was 51% of normal speed. This may be compared with the graduated practice group of Spring 1964 whose comparable mean performances were 28.1% and 60.2% respectively. Although the mean improvement for the latter group was somewhat

Table 2

Significance of Differences Between Means on Listening Comprehension Tests Presented in Table 1

Comparison Between Tests (wpm)	Experimental Groups High Speed (Spring 1965)	Graduated (Spring 1964)	Control Group (Spring 1964)	Significance of Differences High Speed vs. Graduated	High Speed vs. Control
175 - 325	-.57	-1.7	-3.5[d]	N. S.	N. S.
175 - 375(1st)	-2.38[a]	-2.1[a]	-4.4[d]	--	--
175 - 375(2nd)	-2.14[a]	-2.0[a]	-4.4[d]	--	--
175 - 425	-5.14[c]	-3.5[c]	-8.8[d]	N. S.	$<.05$[a]
475(1st) - 475(2nd)	+3.28[d]	+4.6[d]	+0.6	N. S.	$<.05$[a]

[a] $<.05$ one tailed

[b] $<.05$ two tailed

[c] $<.01$ one tailed

[d] $<.01$ two tailed

higher, the difference between groups is not significant. Both, of course, are significantly better than that of the control group.

The decrement in performance from the initial normal speed comprehension measure (at 175 wpm) to the final benchmark test at 425 wpm was greater for the high-speed practice group than for the graduated practice group. The latter did 79.4% as well as normal at 425 wpm, while the former did only 70.6% as well. The difference again, however, was not significant, although both groups were significantly better at 425 wpm than the control group.

The high-speed group achieved 108% of normal score at 325 wpm (at the end of the first weeks practice), while the graduated group reached 87.0%. The control group reached a level of 83.5%. There is no significant difference between any of these groups. Performance at 175 wpm at the end of the experiment was not significantly different from initial 175 wpm mean score for any group suggesting that the procedures had not improved normal speed comprehension.

The overall listening test results suggest that while the concentrated practice group performance was significantly better after training than the control group, they do not quite reach the performance of the graduated practice group, although the standard tests of statistical significance do not support the reliability of such a conclusion.

Reading Results

High-speed subjects were also given alternate forms of the Nelson-Denny Reading Test before and after speeded speech practice. There has been some evidence in the past to suggest that reading skills might benefit from such practice. An examination of preversus post- administration mean scores on the (see Table 3) four measures of the test shows that Reading Rate rose from a mean of 312 to 369 wpm, statistically significant at the .025 level, one-tailed; Vocabulary rose from a mean of approximately 52 to 55 mean score (significant at the .05 level, one-tail) and Comprehension rose from a mean score of 49.5 to 51, an insignificant difference. (The Total mean score which is comprised of vocabulary plus comprehension scores rose from 101.56 to 105.48, a significant difference.)

Experimental subjects in the graduated experiment had also shown a significant rise on all the Nelson-Denny measures. However, the control subjects also significantly improved their performance on both Reading Rate and Vocabulary. It should be remembered that improvement in Vocabulary score is probably closely associated with a higher Reading Rate, since it is unlikely that the size of the subject's vocabulary appreciably increased during the short time of the experiment, but rather that he had read and answered more items. All groups showed a mean increase in the number of the last item attempted. The Comprehension test is constructed such that a faster reading speed does not necessarily mean that more questions will be attempted since it may simply take the subject farther into a passage without enabling him to reach the questions.

A comparison of the concentrated practice subjects with both the experimental and controls of the graduated practice study failed to reveal any significant difference in the improvement shown on Reading Rate and Vocabulary.

The vast majority of subjects tested so far in all experiments have shown an improvement in reading rate; however, because this also applied to the control group, we are not justified in saying that

Table 3

Mean Scores and Standard Deviations of High Speed Experimentals

Nelson-Denny Score	First Administration		Second Administration		Significance of Mean Differences 1st vs. 2nd Ad.
	Mean	S. D.	Mean	S. D.	
Vocabulary	52.05	17.84	54.67	17.63	.05[a]
Comprehension	49.44	11.06	50.79	11.81	N. S.
Total Score	101.56	27.12	105.48	27.99	.05[a]
Reading Rate	312.23	144.65	369.11	134.49	.05[a]
Last Item Attempted Vocabulary	71.41	16.13	78.41	12.54	--
Last Item Attempted Comprehension	29.88	4.25	33.41	3.34	--

[a] one tailed

the improvement was attributable to speeded speech practice. Nevertheless it should be remembered that the control group also had received some hour or so of practice in speeded speech (by taking the benchmark passages) by the end of the experiment.

Repetition

During each of the first three weeks of the experiment, and in the previous ones, one-third of the subject (a different third each time) repeated the passage initially heard at 175 wpm prior to practice. As in previous experiments, a comparison of subjects repeating with those not repeating shows a higher mean score for the "repeats." (See Table 4) At the end of the first three weeks when subjects were tested at 325, 375 and 375 wpm again, non-repeats showed a mean decrement in successive weeks of -2. 10, -3. 99, and -3. 85, while "repeats" show successive increments of +2. 50, +0. 84, and +1. 30. The final high speed passage which was a repeat of the initial 475 wpm passage for all subjects showed a mean increment of +3. 28. This confirms similar results in the other experiments, and suggests that even at high speeds repetition is beneficial to comprehension.

Intercorrelations

Intercorrelations were run between selected listening and reading speed scores (see Table 5). The intercorrelations between normal speed performance and the higher speed listening scores are lower throughout than were those for the graduated practice group. In fact, with the exception of the correlations between 325 wpm scores with 475(1) and 475(2) which are considerably higher, all the listening to listening correlations are lower. There is a highly positive (+. 76) correlation between final 475 and 325, suggesting that a predictor may exist at the 325 wpm level. That is, performance at the early

TABLE 4

Mean Change in Score For Subject Repeating and Not Repeating Passages by Speeds

Speeds Compared (wpm)	Non-Repeats	N	Repeats	N	Time Elapsed (in wks.)
175 - 325	-2.10	12	+2.50	6	1
175 - 375(1st)	-3.99	12	+0.84	6	2
175 - 375(2nd)	-3.85	12	+1.30	6	3
475(1st)- 475(2nd)	---		+3.28	18	4

Table 5

Selected Intercorrelations of Reading & Listening Performance for High Speed Practice Subjects

N=18[a]

wpm	175	325	425	$475^{(1st)}$	$475^{(2nd)}$	Nelson-Denny Pre-Training Total	Nelson-Denny Pre-Training Reading Rate
175	--	.27	.38	.24	.34	.30	-.05
325		--	.40	.55	.76	.58	.40
$375^{(1st)}$							
$375^{(2nd)}$			.42				
425			--	.19	.31	.30	.36
$475^{(1st)}$				--	.55	.51	.49
$475^{(2nd)}$					--	.20	.21
Total Score (N-D)						--	.52
Reading Rate							--
Xe	13.8	13.2	8.6	3.5	6.8	101.6	312.2
Se	4.24	4.76	2.98	2.71	3.65	26.10	144.65

[a] In the intercorrelations between the speeded passages and the Nelson-Denny Total and Reading Rate N=17. One subject was disqualified because he had taken the N-D recently.

stages appear to be related to higher speed performance. However, no clear pattern has emerged to suggest, for instance, that normal and high speed performance are highly correlated, albeit they are in all cases positive. Intercorrelations between listening and reading scores are generally positive, but again slightly lower than those for the graduated practice groups.

Questionnaires

Three questionnaires were given the subjects during the experiment. The first, administered during the third week, asked if the subjects were making progress. The feeling, as in the past, was positive. During each session of the fourth week a quiz was administered on the novel being presented, "Run Silent Run Deep." During the first two sessions scores were much lower than for the graduated practice group (the control group, of course, did not receive the quizzes since they received no practice on the novels.) During the third session, performance improved somewhat, although it still lagged behind that of the graduated practice group. The three successive mean scores (out of a possible 100%) was for the concentrated practice group 26, 25, and 44%, while those for the graduated group were, respectively, 64, 70 and 70%. While the standardized listening test scores were also somewhat lower, the disparity was not as great as this. It may be that this group was not as interested as the first experimental group, to the detriment of their performance.

A final debriefing questionnaire was administered to all subjects as in the previous experiments. The greater part of the subjects felt, as those in the past, that practice in listening helped comprehension, and that more practice would have been more beneficial (although again there were some dissenters). The majority felt that literary, historical, or political material might be suitable for compression as lectures. Seventy-five percent of the subjects said that the breaks (approximately 10 minutes in every hour) were of sufficient duration and frequency; the remainder of the subjects felt that the breaks did not come frequently enough. Among the possible choices of listening aids presented to the subjects in the questionnaire (including note-taking, key-word lists, outlines of material to be heard, repetition, earphones, and a copy of the text), the first choice was a brief outline of the material to be presented. Second choice was a copy of the text to be read simultaneously, third choice, a key-word list or earphones, and fourth choice, repetition of the listening material.

The chief problem indicated, as in the past, was maintaining attention. Most subjects felt that their attention wandered as much as half of the time. All agreed that not every word of the compressed tapes was intelligible. More subjects felt that long words were more intelligible than short ones. Direct quotations was most often mentioned by the subjects as best heard. As in the past, the overall impression of the subjects was favorable to the potential use of speeded speech, though it is probable that subjects feel under a certain amount of pressure, after their investment of time, and ours of money and effort, to respond with a positive answer.

Summary of Results

To summarize the results of this experiment, improvement in listening with practice at high speed was again demonstrated. Subjects showed significant improvement on a repeated passage at 475 wpm at the end of the experiment, and a significantly smaller decrement on a new passage at 425 wpm at the end of the experiment, than did control subjects on either measure. While improvement in reading rate, vocabulary, and total score was again found, these results were not significantly different from those of the control group. A comparison of high speed concentrated practice with practice at gradually increasing speed did not show a significant difference, although mean performance with graduated practice seemed to be generally better.

Subjects felt that they had learned to comprehend rapid speech to some extent, that practice was beneficial, and that there is a place for compressed speech in the educational system.

Further Research

Further experimentation in this series will deal with the use of listening aids both in training and with trained listeners, with the time needed to reach a criterion of performance at high speed, with the nature of material optimally suited for compression, with the retention of content of material learned via compression, and retention of skill; and with the interactions of reading with listening at high speed.

PROCEDURE

Subjects:

W.P.M.	Test + Psg.	A_1	A_2	B_1	B_2	C_1	C_2	D_1	D_2	E_1	E_2	F_1	F_2	G_1	G_2	H_1	H_2	I_1	I_2
		Biographical Data + Audiogram																	
175	C	1	1	4	4	5	5	1	1	4	4	5	5	1	1	4	4	5	5
475(1st)	C	3																	
Nelson-Denny (Form)		A	B	A	B	A	B	A	B	B	A	A	B	A	B	B	B	A	A
425		CHEAPER BY THE DOZEN																	
325	C	1						4						5					
425		MIRACLE N. Y. YANKEES																	
375(1st)	C	4						5						1					
425		MAN-EATERS OF KUMAON																	
		QUESTIONNAIRE																	
375(2nd)	C	5						1						4					
425		RUN SILENT, RUN DEEP																	
		THREE QUIZZES																	
425	C	2																	
425		RUN SILENT, RUN DEEP (LAST SECTION)																	
475(2nd)	C	3																	
Nelson-Denny (Form)		B	A	B	A	B	A	B	A	A	B	B	A	B	A	A	A	B	B
175(2nd)	C	6																	
		DEBRIEFING QUESTIONNAIRE																	

Appendix A-2

Characteristics Of Compressed Speech Passages

Passage	No. Words in Passage	No. indep. Clauses	Avg. No. Wds. Not on Dale List/100	No. Syllables p.100 w.	Avg. No. wds. per Sentence	Listenability	Reading Ease	Duration in Minutes				
								175 wpm	325 wpm	375 wpm	425 wpm	475 wpm
C-1	3803	246	13.7	144	18	15.1	66	21.7	11.4	10.1	NA	NA
C-2	3515	205	11.5	137	22	15.1	68	NA	NA	NA	8.3	NA
C-3	3780	243	12.7	149	18	14.7	62	NA	NA	NA	NA	8.0
C-4	4039	220	16.3	141	18	18.3	69	23.1	12.4	10.8	NA	NA
C-5	4049	229	17.6	148	21	18.5	60	23.1	12.5	10.8	NA	NA
C-6	3320	188	16.0	140	13	17.7	74	19.0	NA	NA	NA	NA
Mean	3751	221.8	14.6	143.2	18.3	16.6	66.5	21.7	12.1	10.6	8.3	8.0

Appendix A-3

Final Prorated Listening Scores by Subject and Rate of Presentation

Words p.min.	A_1	A_2	B_1	B_2	C_1	C_2	D_1	D_2	E_1	E_2	F_1	F_2	G_1	G_2	H_1	H_2	I_1	I_2	MEAN	S.d.
175	12.5	17.5	12.5	18.8	15.2	17.8	10.0	12.5	13.8	7.5	11.5	11.2	18.8	13.8	15.0	18.8	17.5	3.2	13.77	4.24
475(1)	9.4	2.1	4.4	4.2	5.4	3.8	0.0	7.1	2.7	1.9	2.1	6.2	2.9	0.6	0.0	3.3	7.3	0.4	3.54	2.71
325	21.5 (R)	20.0 (R)	15.0	18.8	13.8	14.5	13.8	14.0	17.5 (R)	10.0 (R)	10.0	9.0	10.0	4.8	7.5	8.8	18.8 (R)	9.8 (R)	13.20	4.76
375(1)	21.5	10.2	15.5 (R)	21.2 (R)	8.8	10.5	5.0	12.5	10.0	6.2	8.8 (R)	13.2 (R)	17.5 (R)	11.5 (R)	10.0	8.0	12.5	2.2	11.39	5.10
375(2)	9.5	10.2	11.2	15.0	15.2 (R)	18.8 (R)	8.8 (R)	18.8 (R)	13.8	3.8	5.0	0.8	13.8	14.2	15.0 (R)	13.8 (R)	17.5	4.2	11.63	5.35
425	11.7	9.4	12.1	13.5	6.2	12.1	6.7	9.4	5.2	4.6	11.5	3.3	9.8	7.5	10.4	5.6	9.4	6.9	8.63	2.98
475(2)	13.5	10.6	8.1	6.2	10.4	6.0	5.2	7.1	10.0	3.1	7.3	1.9	1.9	4.8	5.2	6.0	13.5	1.9	6.82	3.65
175(2)	10.0	17.5	14.0	17.5	18.8	21.5	3.8	15.0	13.8	7.8	7.5	13.8	18.8	16.2	5.0	8.8	17.5	8.0	13.07	5.28

Note: The test scores are corrected for chance, pro-rated to a base of 25 items per test, (all 425 and 475 tests were 30 items) and rounded to one decimal place. At the following speeds: 325, 375(1) and 375(2), passages C1, C4, and C5 were each presented to one third of the subjects. (R) indicates the repeat of a passage already heard at 175(1). Passages C2 and C3 respectively were presented to all subjects at 425 and 475 wpm. Passage C6 was a new passage presented at 175(2).

Appendix A-4

First and Second Administration Scores[a] of the Nelson-Denny Reading Test and Last Item Attempted for Experimental Subjects (N=17)

Subject	Vocabulary				Comprehension				Total[b] Score		Reading Rate	
	1st Score	Last Item Att'd.	2nd Score	Last Item Att'd.	1st Score	Last Item Att'd.	2nd Score	Last Item Att'd.	1st Score	2nd Score	1st Rate	2nd Rate
A_1	87.8	100	93.2	100	62.0	36	67.0	36	149.8	160.2	723	670
A_2	61.2	84	65.2	96	52.0	36	54.5	36	113.2	119.8	235	468
B_1	27.8	69	30.2	60	31.0	26	36.0	28	58.8	66.2	275	356
B_2	85.2	100	85.0	100	64.5	36	64.5	36	149.8	149.5	450	501
C_1	41.5	55	42.2	66	46.0	36	52.5	35	87.5	94.8	104	195
C_2	70.0	77	65.2	75	69.5	36	67.0	36	139.5	132.2	279	456
D_1	44.8	66	44.5	79	38.0	29	47.0	36	82.8	91.5	359	279
D_2	54.5	79	58.2	87	50.0	36	57.0	36	105.5	115.2	499	563
E_1	55.0	73	67.0	82	47.5	32	51.5	32	102.5	118.5	214	309
E_2	39.0	59	35.2	77	42.0	31	41.5	27	81.0	76.8	287	226
F_1	36.2	50	40.8	57	43.5	28	26.0	28	79.8	66.8	161	214
F_2	59.8	86	58.2	79	51.5	32	57.5	35	111.2	115.8	226	226
G_1	47.2	56	63.2	78	62.0	36	54.5	36	109.2	117.8	338	403
G_2	33.2	54	35.8	76	33.0	24	43.0	34	66.2	78.8	368	396
H_1	31.2	50	38.5	66	44.5	26	32.5	30	75.8	71.0	203	436
H_2	44.5	72	47.8	72	59.5	36	59.5	36	104.0	107.2	269	287
I_2	66.0	84	59.2	83	44.0	32	52.0	31	110.0	111.2	318	290
Mean	52.05	71.41	54.67	78.41	49.44	32.24	50.79	33.41	101.56	105.49	312.24	369.12

[a] Corrected for guessing.

[b] Totals may not add because of rounding error.

FINAL REPORT

PART 2

Project No. 5-0801

Grant No. OE-7-48-7670-267

FURTHER RESEARCH ON SPEEDED SPEECH AS AN EDUCATIONAL MEDIUM

January 1966

U. S. DEPARTMENT OF
HEALTH, EDUCATION, AND WELFARE

Office of Education
Bureau of Research

FINAL REPORT

PART 2

Project No. 5-0801

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Further Research on Speeded Speech as an Educational Medium

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American Institutes for Research
Silver Spring, Maryland

January 1966

The research reported herein was performed pursuant to a grant with the Office of Education, U. S. Department of Health, Education, and Welfare. Contractors undertaking such projects under Government sponsorship are encouraged to express freely their professional judgment in the conduct of the project. Points of view or opinions stated do not, therefore, necessarily represent official Office of Education position or policy.

U. S. DEPARTMENT OF
HEALTH, EDUCATION, AND WELFARE

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PREFACE

The latter portion of 1965 was a period in which considerable public interest regarding research in the comprehension of time-compressed speech was generated. The Principal Investigator arranged a symposium for presentation to the American Psychological Association in September, 1965. Most of the current research in compressed speech was represented at this symposium. This symposium resulted in a number of articles in various publications, including: Science Newsletter (10/2/65), The Chicago Daily News (9/4/65), The New York Herald Tribune (9/12/65), Education U. S. A. (9/16/65), Washington Post (9/6/65), Newsweek Magazine (9/13/65), and many other newspapers.

On 11 November 1965, our laboratory setting and research were filmed by the CBS Walter Cronkite Evening News Show. The final film, which was presented on the 22 December broadcast, featured Project Director, H. L. Friedman presenting a test to a group of subjects; CBS Washington correspondent George Herman interviewing the Principal Investigator; and the playing of a one-minute selection at 325 words per minute for the viewing audience, coupled with a request for cards and letters answering a question based on the selection and giving opinions about the technique. Editorial commentary was given by Eric Sevareid, and comments were made by Walter Cronkite who used compressed speech for his final sign-off of the evening.

As a result of this program about 4,000 cards and letters were addressed to the Principal Investigator at the P. O. Box number provided on the show. (How many arrived in New York addressed only to CBS or to Walter Cronkite, we don't know.) The bulk of these (about 90 percent) had the correct answer to the question. About half were outspokenly favorable to the presentation (this based on exposure of only 2-3 minutes); and only about 15 percent expressed serious reservations. These reservations were in general concerned with the fast pace of modern life and the development of tension rather than doubts that the procedure would work. (In passing, it should be noted that listening to 325 wpm can be wearing, but that this feeling disappears with practice.)

Finally, CBS footage was made available to the United Press International for use in their monthly filmed edition of Science News Report for the U. S. Information Agency. This film was scheduled for release in February-March 1966 and distribution to about 525 outlets in 75 foreign countries, in 22 different languages from Urdu to French. This represented about 96 percent of USIA stations including Warsaw, Budapest, and Belgrade.

The public reaction described above has not had a great deal of impact on the conduct of the research described in the remainder of this Report. However, it has served to impress the authors with the high degree of potential public acceptance which may be anticipated when these techniques are taken into the field testing and implementation stages sometime during the next year or two.

Introduction and Background

In recent years, considerable attention has begun to be given to raising the rate and level of auditory comprehension. Interest in listening comprehension is of course not new. Interest in the trainability of listening rate is perhaps more recent, but as far back as 1947, Nichols (1947, p. 85) posed the question, "Can listening rate, like reading rate, be increased through training?". Attempts to study rapid speech have invariably reported severe attenuation of comprehensibility with increased rates of presentation. Until recently such studies have used speeded-up tapes or records to increase speech rate and the resulting frequency shift has produced speech of higher and higher pitch. Many investigators concluded that loss of comprehension was as much due to frequency shift as to the acceleration of speech itself.

One investigator, (Garvey; 1953a, 1953b) reasoned that since Miller and Licklider (1950) had demonstrated that good intelligibility remained even after considerable loss of the stimulus word, it would be possible to physically cut out small segments of the speech record and play the remainder, thus compressing the total speech time, but leaving the original frequencies unaltered. Using discrete, spondaic words, Garvey found it possible to compress speech up to 2.5 times without losing more than 20 percent intelligibility.

Garvey's compression technique was far too cumbersome to be applied on any large scale. However, Fairbanks and his colleagues (1954, 1957), developed an electronic device for doing essentially what Garvey did by hand, with similarly encouraging results. More recently, Bixler, Foulke, et al. (1961) began investigations of speech compression as an approach to teaching the blind, again demonstrating the feasibility of the technique.

During the past three years under the sponsorship of the U. S. Office of Education, the authors have conducted investigations at the American Institutes for Research inquiring into the ability of college students to understand tape recorded material at speeds greater than normal. This research has been made feasible by the use of a device (The Tempo Regulator), somewhat similar to that developed by Fairbanks, which electronically removes small segments of the tape recorded speech sounds and abuts the remainder of the speech record together. Since the process removes only segments shorter than the shortest speech sounds, the result is relatively distortion-free; in addition pitch and intonation patterns remain normal.

Previous progress reports have described three major experiments whose results may be briefly summarized as follows: By the end of the experiments, all experimental groups achieved significantly higher comprehension at 425 wpm than the control groups. Three of the four experimental groups showed a significantly higher mean gain score than control groups on a passage given at 475 wpm at the beginning of the experiment and repeated at the same speed at the end. There have been no major changes in pre- and post-experimental reading performance measures. No differences in normal speed listening performance as a function of listening to rapid speech have been detected with an abbreviated version of the STEP Listening Test. Virtually all subjects have reported that they feel that they benefited from practice and that compressed speech has a place in the educational setting. Male and female subject performances were not discriminably different. Increasing the rate of practice material from 325 to 475 in 50 wpm increments seemed somewhat superior to presenting all practice at 425 wpm. Interrupting the usual 45 minute listening sessions for three minute breaks every ten minutes did not improve performance as compared to uninterrupted practice, and, although the differences were not significant, actually appeared to be an inferior method of practice.

The research reported in the present progress report covers three types of experiments conducted since the last progress report (July 1965): The Immersion Study, in which subjects listened to many hours of high speed listening for a week; The Criterion Study in which moderately high speed practice was presented until the subjects reached a pre-set criterion; and the Retention Studies in which an attempt was made to determine how well the skill, and the content of material was retained over a period of time.

The Immersion Study

Problem:

It was the purpose of this experiment to determine the effects of listening practice when that practice was given intensively; approximately 8-10 hours a day for five consecutive days. In previous experiments practice had been presented at high speed exclusively (425 wpm throughout), and at graduated speeds (325, 375, 425, and 475 wpm); but in these cases practice had been given on alternate weekdays and spread over four weeks. In this experiment subjects put in a twelve hour day (9:00 a. m. to 9:00 p. m.) including breaks for meals and rest, and were given practice material only at 425 wpm. The major question asked was whether concentrated practice in a few days could achieve results similar to or better than those provided by spaced practice.

The rationale for the problem was two-fold. In the first place if it should, as seems likely, become feasible to apply time-compressed speech as a general educational technique, it might be necessary to have naive students spend some amount of time practicing the comprehension of time-compressed speech as a precursor to their regular studies. If this were the case, it would be desirable to have such a training course occupy a minimum number of days at the beginning of the term. Secondly, the experience of the Armed Services in recent years in attempting to teach a second language has shown a fair amount of success for intensive or immersion exposure to the target language.

Putting these factors together, it seemed to be worthwhile to see whether or not exposure to compressed speech of the order of 8 to 10 hours a day for a period of a week could produce results equivalent to or better than those which had been previously obtained on a more relaxed schedule.

Procedures:

The immersion study subjects consisted of seven male students, between ages 19 and 20, at the freshmen or sophomore college level. English was their native language and none had a marked regional accent. The average letter grade for all the students in their last semester in college was a C+. Two of the subjects had some training in rapid reading but in both cases the course was not completed. None of the subjects had had any form of training in listening. All of the subjects were screened audiometrically for normal hearing.

In the first session, subjects were given a brief talk explaining that the purpose of this study was to provide intensive exposure to speeded speech, and to measure listening performance with periodic benchmark tests. They were also given a biographical data sheet to fill out which called for basic information about their backgrounds. They were then given alternate forms of the Nelson-Denny reading test which measures reading comprehension, rate, and vocabulary. This was followed by the presentation of an historical passage (taken from the same book as the later benchmark passages) which was presented at normal recording speed (175 wpm). A standard multiple choice test on the information contained in the passage was then given. A similar passage and test was then presented at 475 wpm as an initial measure of high speed performance. Subjects were then asked to return for five consecutive weekdays, beginning on a Monday, from 9:00 a. m. to 9:00 p. m.

During the next week, twelve novels were played at 425 wpm as practice material for the subjects. The experiment was conducted in a semi-soundproofed room and materials previously compressed on the Tempo Regulator were played back on a Magnecord tape recorder through a Bogen amplifier and two Electro-voice speakers. The novels used and the days on which they were presented are shown in Appendix A.

On each day listening material was presented for approximately 48 minutes without interruption. At the end of that time a brief written quiz, including both short answer and essay types of questions, was administered to the subjects during a ten minute period. This was followed by a five minute rest period, after which the cycle was repeated. Subjects were given one hour for lunch during the afternoon, and one hour for dinner in the evening. During the latter part of each of the five days of exposure, a new benchmark passage and test, similar to the pre-experimental material, was administered. Each test was presented at 425 wpm. Near the end of the fifth day, the initial high speed benchmark passage was presented again at 475 wpm.

At the end of testing and again in a post-experimental session about a week later, subjects were asked to rate the novels they had listened to, on a five point scale, covering the following aspects of the presentations: Overall ability to comprehend, intelligibility (clarity of individual words), difficulty of subject matter, interest in the book, quality of speaker's voice, and quality of speaker's diction.

An alternate form of the Nelson-Denny reading test was then presented as a post-experimental measure of change. The subjects were then given an extensive debriefing questionnaire to complete calling for subjective comments on the procedures, materials, and potential usefulness of compressed speech in the educational setting.

Upon the completion of the experiment, each subject was paid $100.00 plus a bonus of $25.00 to the subject who demonstrated the greatest proficiency on the benchmark tests.

Results and Discussion:

Results of the benchmark tests in terms of number of questions correct, based on 25-item tests, corrected for chance, are shown in Table 1. Also shown is percentage of normal speed performance, calculated separately for each individual based on his own performance at normal (175 wpm) speed. It may be noted that there is a progression of means from 40.4% on Day 1 to 70.0% on Day 5, which is reasonably steady with the exception of a dropback on Day 2. In addition to this improvement, mean performance on the repeated high speed passage

TABLE 1

Benchmark Test Scores Corrected For Chance and Percentages of Normal Speed Scores

Subject		Normal	475(1st)	425 WPM					475(2nd)
				Day 1	Day 2	Day 3	Day 4	Day 5	
A		16.25	0.00	6.50	2.75	7.50	8.75	9.37	9.37
	%	100.0	0.0	40.0	16.9	46.2	53.8	57.7	57.7
B		14.00	5.21	9.50	9.75	8.75	7.50	9.58	12.29
	%	100.0	37.2	67.9	69.6	62.5	53.6	68.4	87.8
C		25.00	8.33	15.00	8.75	16.25	10.00	17.70	11.45
	%	100.0	33.3	60.0	35.0	65.0	40.0	70.8	45.8
D		22.50	8.95	16.25	11.50	14.00	13.75	16.09	15.62
	%	100.0	39.8	72.2	51.1	62.2	61.1	71.3	69.4
E		19.25	1.46	0.75	3.75	6.75	14.00	9.58	6.66
	%	100.0	7.6	3.9	19.5	35.1	72.7	49.8	34.6
F		14.25	0.00	1.25	6.50	1.25	3.75	11.45	4.16
	%	100.0	0.0	8.8	45.6	8.8	26.3	80.4	29.2
G		10.00	2.08	3.00	0.50	4.00	6.50	9.16	3.96
	%	100.0	20.8	30.0	5.0	40.0	65.0	91.6	39.6
Mean		17.32	3.72	7.46	6.21	8.36	9.18	11.84	9.07
	%	100.0	19.8	40.4	34.7	45.7	53.2	70.0	52.0

(475 wpm) also improved from 19.8% to 52.0%, which is significant at the one percent level. The progression of means is shown graphically in Figure 1.

With the exception of the 475 wpm passage and test, the figures shown in Table 1 and Figure 1 are based upon different tests and test passages are thus independent estimates of performance. Passages were taken from the same book of early English history, however, and tests were constructed to be equivalent according to item statistics derived from the same population of students.

As an illustration of the extent to which variables such as material and subject variability and type of test can affect the results, however, one may consider the results for the short answer tests and essay tests on the practice materials. These were not intended to do more than motivate the subjects to listen to the practice materials, and it was not possible to standardize these measures. The results on these tests showed no discernable trends and great subject variability. The lack of correlation between short answer and essay results (R=0) indicated further that such measures are not very dependable. To the extent that investigators are led to depend upon such "pick-up" measures, their research can certainly be open to question.

With respect to pre- and post-test scores on the reading and standard listening tests, mean increases of about 7-8 percent were observed in each case. Of course, these results were not significant with an N of only 7.

The results of the present experiment again confirm previous findings that comprehension of time-compressed speech can be improved by simple practice routines to relatively high levels at speeds of about

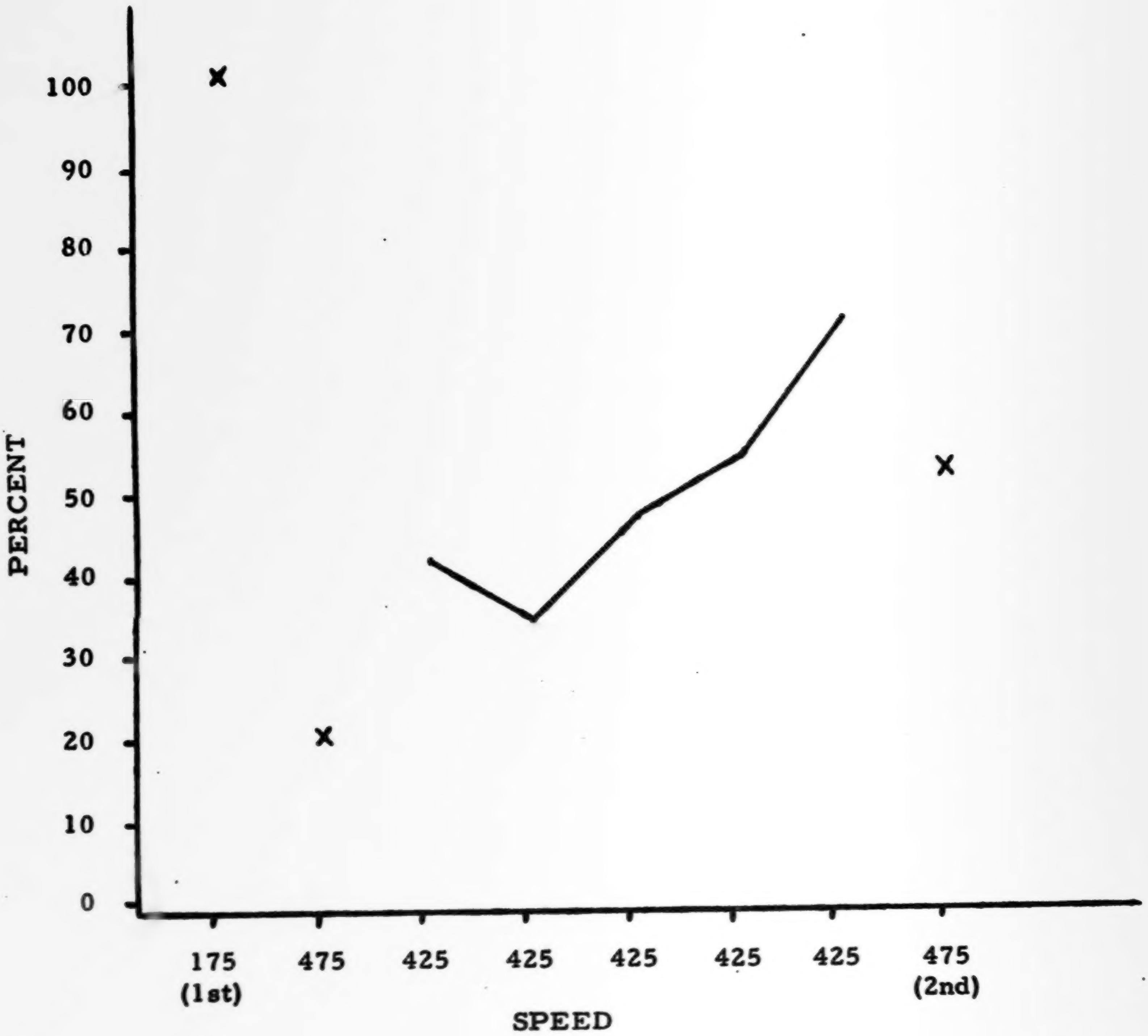

Fig. 1. Mean Percent of Normal Performance Over Five Days (N=7)

2-1/2 times normal. By the end of the week, all subjects had reached the 50 percent comprehension mark, although several started from as low as 5-10 percent on the first day. There is reason to believe that some further increases would have been obtained had the experiment been prolonged. The effects of the training on other variables such as reading test scores and standard listening test scores, while in the right direction, were not great, however.

Another question of interest is the effectiveness of the method here employed to achieve approximately 70 percent comprehension at 425 wpm. During their five days of intensive exposure, these subjects spent approximately 35 hours listening to compressed speech. How does this compare with previous findings? These results can be compared with those of the three previous groups of similar composition, all of which received about 12-14 hours of practice distributed at about 1-2 hours, 2-3 days per week, over about 4-5 weeks:

(1) Graduated practice from 325-475 wpm

(2) Graduated practice from 325-425 wpm (with periodic breaks)

(3) High speed practice (425 wpm only)

The mean result for group (1) above was 79 percent of normal at 425 wpm; for group (2) 80 percent at 425 wpm; and for group (3) 71 percent at 425 wpm. Thus, the investment of 12-14 hours of spaced practice produced results as good or better as the investment of almost three times as much practice in the present "immersion" study. A similar conclusion was reached after looking at the mean improvements from pre- to post-experimental scores on the repeated high speed (475 wpm) test passage.

With respect to the subjective comments gathered on the debriefing questionnaire, a few comments can be made. All subjects felt that practice had improved their ability to comprehend compressed speech and five of the seven felt that more practice would lead to further improvement. Attention wandering, particularly on less interesting parts of the practice material, was seen as one of the chief problems. However, most felt that their powers of concentration had been improved by the experiment. Finally, all subjects felt that their performances would be improved with the use of learning aids, such as outlines, key words, abstracts, simultaneous availability of the text, and selected repetition.

Summary and Implications:

The primary findings of this study were two-fold: (1) The findings of previous work were confirmed in that time-compressed speech is comprehensible, and the comprehension of time-compressed speech is trainable by means of simple practice; (2) While immersion in concentrated practice is effective in improving comprehension at high rates of speed, it is not an efficient method of practice as compared to less concentrated types of practice spread out over a longer period of time.

The findings of the present study tend to reinforce the conclusion that time-compressed speech offers substantial possibilities as an educational technique. Comparatively high levels of comprehension are possible after comparatively limited amounts of training at substantially increased rates of speed. Rather high levels of comprehension at 2-1/2 times normal speed can be obtained in a period as short as one working week by means of concentrated practice. Thus, the findings do confirm the feasibility of a concentrated training course in compressed speech as a prelude to the regular school term, if the use of highly compressed speech should become a usual educational practice.

The Criterion Study

Problem:

The aim of this study was to determine the amount of practice listening necessary to reach the criterion of 90 percent of normal speed comprehension at the 375 wpm level. In previous experiments significant improvement in performance occured at 425 and 475 wpm, but the mean scores were well below 90 percent. It was the aim of this study to achieve 90 percent comprehension at a moderately high speed, and if successful go on to still higher speeds.

In addition, the method of measuring comprehension used to date has been rather cumbersome, requiring the use of entire passages and the construction of equivalent tests. Therefore, it was planned to examine an intelligibility measure (accurate reporting of the last word heard at certain intervals) as a possible correlate of comprehension.

Procedures:

The subjects used were ten male volunteers from the University of Maryland (nine sophomores and one freshman) between the ages of 18 and 22. None had previously participated in a compressed speech experiment. All had normal hearing as determined by a pure tone audiometric screening test; and all were native speakers of English with no marked regional accents. Subjects were paid $1.50 per hour plus carfare. In addition, six $10.00 bonuses were awarded during the course of the experiment on the basis of performance on the first administration of the listening tests.

The subjects were informed that throughout the experiment bonuses* would be paid for outstanding performance, and they must attend every session in order to receive payment for their participation. They were asked not to discuss the experiment with each other or outsiders. No feedback was given to the subjects regarding their scores.

The materials used were as follows:

a. Practice novels: Three novels previously recorded by the American Printing House for the Blind in their Talking Book series were selected and compressed to the required speeds:

(1) Cheaper by the Dozen. The first quarter at 325 and the remainder at 375 wpm.

(2) The Miracle New York Yankees at 375 wpm.

(3) Run Silent, Run Deep at 375 wpm.

Of the ones previously used at this speed, these had been the most popular.

b. Test materials:

(1) Quizzes on the information contained in the novels were used. They were comprised of multiple choice and essay questions, but were not standardized. They were written for a previous study and were used here to give the experimenters

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* These bonuses were awarded after performance on the first administration of the listening tests at 375 wpm. One bonus was awarded after each test. The award was announced at the immediately succeeding session. A bonus was given to the subject with the highest percent normal score on a given test, provided that his absolute score corrected for chance, was above the group mean. Subjects were not informed of the method of awarding bonuses, nor that the bonuses were given on the basis of the first administration only.

some idea of performance and to maintain subject motivation at a relatively high level.

The texts of the novels were used as follows: Each novel was marked at certain intervals at the ends of paragraphs. The tape was stopped at those intervals and the subjects were requested to write down the last word heard. They were asked to guess if uncertain. The ends of paragraphs were chosen to minimize disruption to the subjects and to maximize intelligibility scores since the high degree of contextual restraint could be expected to reduce the number of alternative responses from which the subjects might choose. The intervals were irregular to lessen the predictability of their occurence.

(2) Seven benchmark passages with five-option multiple choice tests were used. (These passages have been described in previous progress reports.) The passages were taken from a college level English history textbook called The English People on the Eve of Colonization, by Wallace Notestein. Twenty-five to thirty item multiple choice tests previously constructed and standardized on a similar population were employed as the chief measures of listening comprehension.

One passage ("C-1") was presented at normal recording speed (175 wpm), the remaining seven at 375 wpm.

Other materials consisted of pre-numbered pages on which the subjects were to record the "last-word heard" responses - there were always more numbers than responses called for to prevent subjects from knowing when that type of testing was completed. Alternate forms of the Nelson-Denny Reading test containing measures of reading rate, vocabulary, and comprehension, were used in a balanced way as pre- and post-experimental measures. The mechanical equipment was the same as that used in previous experiments. In addition a biographical questionnaire and a debriefing questionnaire calling for subjective reactions were used, respectively at the beginning and end of the experiment.

c. Test scoring: Most of the multiple choice tests contained 25 questions; two contained 30 questions. Scores on those two tests were pro-rated to give a proportional score for a 25 item test. All test scores were corrected for chance with the following formula $R - \frac{W}{n-1}$, where R equals the number of questions answered correctly; W, the number of questions answered incorrectly, and n equals the number of alternative answers for any given question.

Each subject's score on the first benchmark passage and test (given at 175 wpm) was taken as the baseline for his comprehension at normal speed. Each subject's subsequent scores were then expressed as a percentage of his score at 175 words per minute.

Scoring of last words: Words were scored correct or incorrect; hyphenated words were counted right if the last word was right. If the word had the wrong ending, it was counted wrong; if wrongly spelled, even homonyms, it was counted right.

Design:

Pre-experimental measures included the following: a biographical questionnaire, the administration of form A to one half the subjects (and form B to the other half) of the Nelson-Denny Reading test; and a benchmark passage at 175 wpm. Following the initial session, experimental sessions lasted about three hours. Subjects never listened for more than one hour to any material without being given a ten minute break. All practice material (novels) was interrupted periodically for recording of "last words" and listening quizzes.

Five benchmark passages were presented at 375 wpm after 2, 7, 9.5, and 16 hours of listening practice. Following the administration of each passage and test 20-25 minutes of additional practice material was presented, after which the passage and test were administered a second time, with periodic interruptions during administration for measurement of "last word" intelligibility. (The exception was C-7 on the last day which was repeated without interpolated practice because of a shortage of time.) Finally, an additional passage and test were presented (but only once, with no interruptions) as the final performance measure. In addition the alternate form of the Nelson-Denny Reading test was administered; and subjects were required to fill out the debriefing questionnaire.

Results:

Table 2 shows the normal speed scores corrected for chance for each subject and the mean percents of these scores attained by the subjects on both first and second administrations separately. It also shows the highest percents of normal attained by each subject on the first administration and the number of practice hours at 375 wpm taken to reach that level.

Table 3 shows the mean percent normal comprehension over all subjects, by number of hours of practice for first and second admin-

TABLE 2

Highest Percent Normal Comprehension Attained By Subject and Number of Hours Practice to Achieve It (375 wpm)

Subject	Normal Speed (175 wpm) Score	Mean Percent Normal 1st Adm.	Mean Percent Normal 2nd Adm.	1st Adm. Highest Percent of Normal	Hours to Highest Percent
A	12.5	67.4	116.2	104.00**	16.0
B	17.5	46.7	73.0	85.71*	7.0
C	17.5	53.7	98.3	100.00	9.5
D	17.5	66.3	85.8	100.00	16.0
E	13.8	50.6	68.6	83.27*	2.0
F	13.8	58.8	121.9	90.91	16.0
G	17.5	73.1	102.5	95.71	16.0
H	13.8	77.7	112.9	116.36	7.0
I	16.2	61.8	106.4	73.85*	9.5
J	15.0	68.2	94.6	91.67	7.0
MEAN	15.5	62.4	98.0		10.6

* Below criterion

** This is the only subject who reached criterion on more than one occasion. His percent normal comprehension was 94.00, after 15 hours of practice.

TABLE 3

Mean Percent Normal Comprehension by Hours of Practice Listening, First and Second Administrations, 375 wpm (N=10)

	Approximate Hours of Practice Novels and Passages						
	2	7	9.5	13	15	16	Mean
Mean %, 1st Adm.	58.8	77.2	58.3	48.7	54.5	77.2	62.4
s.d.	9.8	16.4	27.1	16.6	22.2	20.5	9.5
Mean %, 2nd Adm.	86.5	94.5	102.2	95.6	97.8*	--**	98.0
s.d.	24.4	27.0	25.8	32.0	18.4	--**	16.9

NOTE: The 2nd administrations came after about 20-25 minutes additional practice.

* No interpolated practice between 1st and 2nd administrations.

** C-8 was not re-administered because it was to be used again in a later stage of experimentation.

istrations of the test passages. Unlike previous experiments, there appeared to be no progressive improvement in these means with practice.

Table 4 shows the percent correct for last words on the test passages. Again no evidence of progression is apparent, although the generally high level of intelligibility is evident.

Although seven subjects attained criterion in this experiment, it is unlikely that these subjects attained a highly stable degree of comprehension of speeded discourse at 375 words per minute. Six subjects attained their highest comprehension within the first three sessions; however, these subjects did not maintain this level of comprehension. Even so, it was decided to carry out additional experimentation for two reasons. First, the last word scores did not appear to be a measure which might substitute for the multiple choice comprehension tests. Secondly, a comparison between mean scores on the last two first administrations of comprehension tests given on the final day (with no intervening practice) shows the mean score to be considerably higher on the second test (and all but one subject did better on the second test). Therefore, it was thought that practice consisting only of listening to materials similar to the test materials used and of test-taking on those materials, might produce higher comprehensions scores. That is, that the more similar practice materials were to the materials for which a subject was being trained, the better the performance might be on the latter.

Criterion Study, Part II

Six of the subjects who reached the criterion were asked to return for participation in a second criterion study in which the rate of speeded discourse was 425 words per minute. The subject who reached criterion

TABLE 4

Percent Last Words Correct
By Test and Subject

Subject	C-3	C-4	C-5	C-6	C-7	MEAN
	Passage and Test*					
A	89	53	70	78	86	75.2
B	79	73	75	72	93	78.4
C	95	73	65	89	79	80.2
D	89	80	90	78	93	86.0
E	84	80	85	83	93	85.0
F	100	80	90	94	93	91.4
G	79	87	90	94	86	87.2
H	89	80	100	94	93	91.2
I	95	73	85	94	93	88.0
J	95	87	90	94	93	91.8
No. of trials (Base of %)	19	15	20	19	14	
Mean %	89.4	76.6	84.0	87.0	90.2	85.4

* In chronological order

after 9.5 hours of practice was not asked to return because his scores on the last three tests and his overall mean score were substantially below the group means. Another subject could not return, leaving five.

An artificially formed control group was formed from those subjects from prior experiments who had met the criterion at 375 wpm. Their scores on a standardized test at 425 wpm, after a given number of hours practice of novel listening, could be compared with the results of the present experiment in terms of scores on the same standardized test in order to discover if the method of training by similar materials and testing on those materials was superior to the method of training by listening to novels.

Procedures:

The experiment was conducted in four group* sessions, of three hours each, spread over eight days.

Materials: Ten practice passages and practice tests, taken from a variety of library and journalistic materials were used. One passage was taken from On the Eve of Colonization, the same book from which the passages in Experiment I came; this passage had been equated, and the test standardized with four standardized tests and passages used in Part I. Other materials used were the same as in Part I; however, the hearing test and Nelson-Denny Reading test were not given.

The experimental schedule was somewhat more involved than that for Part I, and is given below by days:

Day 1: Subjects' maximum oral reading rates were tested. Subjects listened to four short passages, of about 10 minutes duration each. After each passage, the subjects were given multiple choice questions about the passage. Each passage and test were repeated twice in succession. During the repetition of each passage about 10 interruptions occurred, of about 5 seconds duration, each; and subjects were asked to record the last word they had heard before the interruption.

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* One individual session was arranged because of scheduling difficulties.

Day 2: Subjects listened to four short unstandardized passages; the method was the same as Day 1. Between the second and third passages, subjects listened to a continuation of Run Silent, Run Deep at 425 words per minute, for about 20 minutes. It was thought that maximum oral reading rate might be correlated with ability to comprehend rapid speech. Therefore the subjects were given a passage to read out loud. They were asked to read the passage as rapidly as possible. The time from beginning to end of the passage was taken for each subject.

Day 3: Subjects listened to two short passages, in the same manner as Days 1 and 2. They then listened to the test passage for this experiment, taking a standardized multiple choice test. The passage was repeated with interruptions for recording of the last word heard. The test was repeated. After all testing for the day had been completed, subjects listened to the final portions of Run Silent, Run Deep, at 425 words per minute.

Day 4: A passage was repeated for the third time, reading questions first. A second passage was repeated for the second time. Subjects were asked to make any comments they wanted to, in writing.

Results and Discussion:

Table 5 shows the results of the criterion study, Part II. It is evident that the subjects did slightly less well on the average than they did in Part I, for both first and second administrations of the practice

TABLE 5

Percent of Normal Speed Comprehension Scores by Subject and Amount of Practice at 425 wpm, Criterion Study, Part II

Subject****	*Mean, 1st Adm. 9 Practice Pass.	*Mean, 2nd Adm. 9 Practice Pass.	**Test Pass. C-2	Test Pass. C-2 (repeat)	***Test Pass. C-8
D	50.8	77.3	29.8	90.5	107.1
	(66.3)	(85.8)	(100.0)		
F	54.0	105.0	77.2	153.0	94.6
	(58.8)	(121.9)	(90.9)		
G	70.1	104.9	59.5	125.0	85.7
	(73.1)	(102.5)	(95.7)		
H	78.4	110.8	65.2	115.1	125.4
	(77.7)	(112.9)	(90.9)		
J	62.2	99.7	73.6	127.8	125.0
	(68.2)	(94.6)	(45.0)		
MEAN	63.1	99.5	61.1	122.3	107.6
	(68.8)	(103.5)	(84.5)		
Average Cumulative Average amount of practice (hrs), Part II	.97	1.1	2.2	2.3	3.0

* Criterion Study, Part I mean scores (375 wpm) are given in ( ) for comparison.

** For comparison the last test passage score in Part I (375 wpm) is given in ( ).

*** This passage was a repeat of the last passage given in Part I at 375 wpm.

**** Refers to Part I Identification Code.

passages. Of course the Part II scores represent tests at 425 wpm, while the Part I scores were taken at 375 wpm. Thus the additional practice was not sufficient to offset the increase in rate.

The comparatively large difference between mean percent of normal for a new test passage in Part II as compared to the last test passage in Part I for these subjects suggests more than simply a loss attributable to the increase in speed. Possibly there was a diminution in motivation during the Part II experimentation, which should have been getting somewhat boring to these subjects by this time.

The efficacy of repetition continued to be clearly evident, as it was in Part I.

When the performance of the Part II group is compared to the ad hoc group of subjects from previous experimental groups who had reached 90 percent at 375 wpm at some time, we find that the Part II group mean on a new passage at 425 wpm was 61.1 percent versus 8[illegible].8 percent for the comparison group. This difference cannot be attributed to differences in amount of practice as the Part II group had a slightly greater number of total hours of practice. This finding is certainly not stable because of its ad hoc nature, but does not provide any support for the hypothesis that practice on materials similar to the test materials was superior to practice on the novels.

A number of rank order correlations were done to tentatively examine the relationships in the data. Few consistent relationships were observed. For the Part I group, a correlation of .50 was obtained between mean last words on the first administration of practice passages and comprehension score on the first administration of a new test passage. Although this is a relatively stable estimate, when the last words score was correlated with comprehension score on the same passage, the correlations ranged from .72 to -.51 over five passages. It can only be concluded that the last words score is no substitute for comprehension scores. Part II results bore out this conclusion.

One interesting result of the last words data however was the finding that some subjects did comparatively well on the listening comprehension score for a test passage, but relatively poorly on last words. This indicates that comprehension is not unduly dependent upon the intelligibility of specific words.

One further correlation was computed for the Part II subjects, reading rate (aloud) with comprehension score on a new passage toward the end of the experiment. A rank order correlation of .70 was obtained which is also probably not a highly stable result.

The comparatively disappointing results of the Criterion study may be due to one or more of several factors. First the interruptions associated with determining last words may have been disruptive. Secondly, the repetition of material may have proved boring to the subjects. Third, it was subsequently discovered that the subjects had set up a "bonus pool" amongst themselves to distribute the bonuses. This raises some questions as to the legitimacy of the results. In any case however, the Criterion study must be taken as tentative and on the order of a pilot study. It did serve the useful function of permitting the try out of a number of new techniques and procedures.

Summary:

1. Seven of ten subjects reached 90 percent of normal speed score at least once on a listening test presented at 375 wpm after up to 16 hours of listening practice at 375 wpm. Subjects could not be con-

sidered to have reached the criterion consistently, however as little evidence of progressive improvement with practice was found.

2. There was no clear correlation between the intelligibility measure and comprehension scores, correlations vascillating from positive to negative.

3. The second presentation of a passage almost always resulted in a much higher score. This effect cannot be attributed simply to repeated questions.

4. Subjects generally did not achieve criterion at 425 wpm within the limits of the 3 or so hours of additional practice material employed.

5. There was no evidence to suggest that practice on materials similar to test passages was superior to practice on novels.

6. A hint of relationship between oral reading rate and listening comprehension at 425 wpm was found.

The Retention Studies

Introduction:

In addition to the questions of how well it can be understood, and to what degree it is trainable, a major question in using compressed speech as an educational technique is to what extent the skill of listening to compressed speech is retained, and to what extent material learned via compressed speech presentation is retained. The three experiments described below provide some information regarding these questions.

Retention Study No. I

In November of 1964 eleven of the original (Spring, 1964) sixteen experimentals, and thirteen of the original sixteen control subjects (from the graduated practice experiments) returned for a single session. (For original data see Progress report June 1964.) The purpose of the session was to measure both degree of retention of content of material heard at a variety of high speeds the previous spring; and to measure the degree to which the skill of comprehending high speed speech was retained.

For the measurement of content retention the tests which had originally been administered after presentation of passages C1 - C5 at speeds ranging from 175 to 475 wpm, were readministered without any passage presentation. For the measurement of skill retention a new equivalent passage and test were presented at 425 wpm.

A comparison of experimental and control mean scores over the five tests (C1 - C5) which were administered without presentation of the passages, showed no difference between the groups. The respective mean scores of the experimentals and controls were 6.9 and 8.0 over all passages and were not significantly different. Since the original presentation of the passages occurred under varying conditions of speed and amounts of practice, the percentage of loss cannot be adequately determined. However, the lack of difference at this point suggests that experimentals retained their content as well as controls did.

Performance on the new passage (C-6) was compared with performance on a similar passage (drawn from the same book by the same author) which was presented at the same speed (425 wpm) at the end of training in the spring session. Mean performance for those experimental subjects able to return declined from 11. 7 in the spring to 9. 1 in the autumn (based on 25-item tests, and corrected for chance). Control subjects showed a decline from 8. 5 in the spring to 7. 5 in the autumn. While the decline for both groups was statistically significant at the five percent level (one-tailed), these losses of 22 percent and 12 percent respectively are not statistically different and may be considered quite modest over an interval of about 4 months.

Although the experimentals still performed better (9. 1 vs. 7. 5), they were no longer statistically different from the controls. Even so, it should be noted that there was some indication that the control group was a superior listening group to begin with. (The respective original scores at normal speed for experimental and control groups were: 16. 0 and 17. 6; at 475 wpm they were 4. 2 and 6. 5.) There was therefore, a tentative suggestion that even six months after training some training effects may have remained with the experimental subjects.

An examination of correlation between initial (prior to any training) performance at normal speed with current 425 wpm performance showed about the same correlation for experimentals (. 56) as for controls (. 39). As the former is significant, while the latter is not, some effect of the practice on the interaction with normal listening is indicated. A comparison of correlations between performance at high speed (425 wpm) immediately after training (spring) and current 425 wpm performance showed a striking difference between experimentals and controls (. 73 vs. . 17). This significant difference further suggests some residual effect of the practice listening received by the experimentals.

Retention Study No. II

During the Spring of 1965, it became necessary to standardize some additional benchmark tests and passages. Therefore a group of college freshmen and sophomores comparable to those students used as subjects was assembled and given the new passages and tests along with several old ones. One month later they were re-assembled and the tests repeated without the passages.

Procedures:

Passages C-3, C-6, C-7, and C-8 were administered in that order at 175 wpm, each followed by its test. Finally Passage C-2 was administered at 425 wpm. Students were urged to do their best, were paid $7.00 and a $15.00 bonus for the best overall score was offered.

One month later the group was re-assembled and the tests for C-3, C-6, C-7, C-8 and C-2 were re-administered without exposure to the passages. Following these a new passage and test was administered at 425 wpm and another new passage and test was administered at 325 wpm. Again the students were paid for their time and a bonus was awarded.

Results:

The results are summarized in Table 6. It may be seen that on the average about 60 percent of the content of the four passages presented at 175 wpm was retained over the period of one month. This finding compares favorably with the retentions of similar materials which have been read.

The loss in retention of 90 percent between first and second administrations of C-2 is certainly not discouraging evidence of retention of

TABLE 6

Mean Scores, Corrected for Chance and Prorated to a Base of 25 Items for Retention Study No. II (N=35)

Passage & Speed	1st Session Mean	2nd Session Mean	Percent Loss
C-3 (175)	13.9	9.2*	34
C-6 (175)	16.3	9.7*	40
C-7 (175)	9.5	4.7*	51
C-8 (175)	12.6	7.9*	37
C-2 (425)	5.7	5.2*	9
C-4 (425)		2.4	
C-5 (325)		3.0	

* Retests

high speed presentations. The level of initial performance at this speed (remembering that these students had had no prior exposure to speeded material) was about 43 percent of normal speed comprehension, which is just about typical for naive subjects at 425 wpm. This percentage jumped to 66 percent on the re-test however, since comparatively greater loss occurred for the normal speed than for the speeded material. Although the scores were corrected for chance, it is likely that some of this stability at high speed was a function of prior knowledge and chance. In any case, however, the retention of content certainly appears to be no worse for speeded material than for normal speed material.

The new passage (C-4) administered at the second session was intended to provide a comparison between the scores for the group on their first exposure to a speeded passage (C-2, first session) and their scores on a comparable new passage one month later. Thus, if they had acquired any skill in the first exposure, the second would measure the retention of that skill.

It was recognized that this test was not a strong one since the amount of skill which could be expected to result from a single exposure would necessarily be small. However, the comparison was made. Table 6 shows that the group score was significantly lower at the time of second testing at speed 425. This lower score can also be attributed to the fact that while the experiment was in progress, frequent interruptions occurred due to factors beyond the control of the experimenter. Similarly the group mean score for skill at listening to 325 wpm without prior experience with this particular speed was extremely low. In fact, the mean score at 325 wpm was lower than the mean score the group obtained upon first listening to 425 wpm. It therefore seems likely that the tests measuring this group's retention of skill in listening to speeded speech cannot be said to allow us to interpret in any meaningful way the retention of this skill.

In summary, then, this experiment provided tentative evidence that listening retention over a month compares favorably with reading retention; and that retention of speeded presentations appears to be at least as good as for non-speeded presentations.

Retention Study No. III

A further examination of the question of retention was obtained by recalling the Spring 1965 experimental group which had practiced comprehension of speeded speech on the order of 12 hours, all at one high speed (425 wpm). This group had performed in a manner comparable to previous experimental groups (See Progress Report No. 1, July 1965), and had displayed a significant improvement in comprehension as a function of practice. It thus could be called a group of practiced listeners.

Procedures:

The group was recalled one month after the conclusion of their experimentation and the procedure of Retention Study II repeated. Tests on passages C-1, C-4, and C-5 which had been originally heard at some combination of 175, 325 and 375 wpm were re-administered without the passages. The same was done for tests on passages C-2, C-3 and C-6 which were originally heard at 425, 475, and 175 wpm, respectively. Finally, new passages and tests C-7 and C-8 were administered at 425 and 325 wpm, respectively.

Results:

Table 7 shows the results of this testing. Again, content retention

TABLE 7

Mean Scores, Corrected for Chance and Prorated to a Base of 25 Items for Retention Study No. III (N=16)

Passage & Speed	Experimental Sessions Means	Recall Session Means	Percent Loss
C-1 (175)*	9.8	8.3	15
C-4 (175)*	11.2	7.5	33
C-5 (175)*	9.1	5.9	35
C-2 (425)	7.0	8.1	-16 (gain)
C-3 (475)	5.6	5.5	2
C-6 (175)	12.9	8.2	36
C-7 (425)		6.0	
C-8 (325)		11.8	

* A mixture of speeds (175, 325, and 375 wpm) occurred on the 1st administration.

of both normal, and particularly speeded passages was high over this one month period. For highly speeded passages (425, 475 wpm) retention was 116 percent and 98 percent respectively of first session scores. For passages presented at normal or for some mixture of normal and speeds up to 375 wpm retention averaged about 70 percent of first session scores.

A comparison of the mean score on the new passage at 425 wpm at the second session with the mean score on a different 425 wpm passage at the end of the experimental sessions one month earlier shows a loss of only 14 percent. However, the obtained mean score on this skill retention test (6. 0) was not significantly different from that obtained by the Retention Study No. II group on its first exposure to compressed speech at 425 wpm (5. 7). This latter score was 43 percent of normal speed scores for the Retention Study No. II group, while a comparison of the present retention groups mean score at the recall session to their original normal speed scores of the previous month (i. e., to a normal speed naive base) also showed 43 percent. Thus, there is little evidence available in this study for retention of acquired skill in listening to compressed speech.

Further, comparison of the recall session mean score at 325 wpm (11. 8) with the mean score of a composite of several passages at 325 wpm (13. 2) on the experimental sessions a month earlier showed a loss of about 11 percent over the period of the month. This comparison shows only a slightly better score one month after the experiment than would be expected from a naive group at this speed. Again, little evidence of skill retention is apparent.

Overall Summary

The experiments described in this Progress Report are of three types: The Immersion Study consisting of intensive practice over a short period of time; the Criterion Study in which it was attempted to bring subjects to a criterion of 90 percent of normal speed comprehension scores at 375 and 425 wpm; and the Retention Studies which sought to measure the degree to which subjects retain both the skill and content of speeded speech listening.

The Immersion Study confirmed previous research in that practice in listening to compressed speech improves performance at 425 wpm. The intensive nature of the exposure achieved results comparable in level to those of previous experiments, at the cost of more than doubling the total amount of listening practice required although this was accomplished in one week instead of four.

The Criterion Study was somewhat disappointing in spite of the fact that seven of the ten subjects achieved the criterion level (90 percent of their own normal performance) at 375 wpm. The results however were rather inconsistent and it is questionable that any subject would score consistently at or above criterion. This was the only experiment to date in which the group did not show a significant upward trend, and it is felt that the introduction of frequent pauses to measure intelligibility may have created too much distraction for effective practice listening. The intelligibility measure suggested that the material used was highly intelligibile, however contrary to predictions, it did not correlate significantly with comprehension scores.

The second part of the Criterion Study at 425 wpm was similarly unrewarding, although it was again demonstrated that repeating a passage produced great improvement over the first exposure. These repetitions may also have contributed to lack of overall improvement, however, by introducing monotony. Further there was no evidence that practicing on test-like material was more effective than practicing on novels.

The three Retention studies suggested that the content of that which is learned by listening to compressed speech is as well retained as that learned by listening to normal speed tapes. However, the results obtained in testing the retention of the skill in listening to high speed speech were somewhat inconclusive. Study No. I provided some positive evidence of retention of skill, but study no. III failed to bear this out (Study No. II was essentially irrelevant on this point.) Of course, measurement of retention using the "savings" method, measuring the amount of time to re-train, might provide more positive results. It should be borne in mind that if speeded speech were to be used in the educational setting it would not be presented only at isolated times separated by long intervals. It is felt that if consistent use is made of compressed speech, the skill would not be lost.

Further Research

Additional work remains to be done. Under the present grant it will include the following categories of experimentation:

1. An examination of a variety of listening aids including summaries of listening material, key word lists, greater isolation of subjects, etc. as a better means of training comprehension of speeded speech.
2. An examination of the use of compressed speech with different types of material than those used to date. It is planned to use psycho-

logical and physical science material as opposed to the literary-historical material currently being used.

3. An examination of the usefulness of speeded speech as a review technique. Students who are familiar with specific material will be able to review this material by listening to compressed tapes of it as compared with a control group reviewing in the conventional manner.

4. An examination of the variables involved in the simultaneous presentation of visual and auditory material, compressed in time.

5. An exploration of self-pacing techniques (i. e., the adjustment by the listener of the rate of presentation of material to which he is listening) as a means of learning more about comprehension and training of compressed speech.

6. Additional retention studies employing the "savings" method to bring subjects back up to a criterion level of performance.

7. An additional examination of the impact of training on normal speed performance.

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APPENDIX A

Immersion Study

Practice Materials and Schedule of Presentation
(all at 425 wpm)

	Material	Elapsed Time
(Day 1)	Cheaper by the Dozen	45
	Quiz	10
	Break	5
	Cheaper by the Dozen	40
	Quiz	10
	Cheaper by the Dozen	65
	Quiz	10
	Quiz	10
	Break (lunch)	60
	Diary of a Young Girl	67
	Quiz	5
	Break	10
	Diary of a Young Girl	59
	Quiz	10
	Break	15
	Diary of a Young Girl	43
	Quiz	5
	Break (dinner)	60
	Benchmark Passage C-4	12
	Test C-4	13
	Diary of a Young Girl	48
	Quiz	5
	Break	10
	I Owe Russia $1200	79
	Quiz	8
(Day 2)	I Owe Russia $1200	60
	Break	10
	I Owe Russia $1200	25
	Quiz	5
	Quiz	5
	The "Miracle" New York Yankees	49
	Quiz	5
	The "Miracle" New York Yankees	15
	Break (lunch)	65
	The "Miracle" New York Yankees	32
	Quiz	5
	The "Miracle" New York Yankees	32
	Quiz	4
	Break	20

APPENDIX A

	Material -	Elapsed Time
	To Kill a Mockingbird	57
	Quiz	5
	Break	15
	To Kill a Mockingbird	54
	Quiz	6
	Break	10
	To Kill a Mockingbird	54
	Quiz	3
	Break (dinner)	60
	Benchmark Passage C-5	10
	Test C-5	10
	To Kill a Mockingbird	44
	Quiz	3
	Break	2
	To Kill a Mockingbird	45
	Quiz	5
(Day 3)	The Excitement of Science	53
	Break	14
	The Excitement of Science	9
	Quiz	7
	The Excitement of Science	30
	Break	13
	The Excitement of Science	31
	Quiz	5
	Break (lunch)	65
	The Forgotten Pioneer	65
	Quiz	5
	Break	15
	Man Eaters of Kumaon	47
	Quiz	7
	Break	18
	Man Eaters of Kumaon	52
	Quiz	7
	Break	5
	Man Eaters of Kumaon	19
	Break (dinner)	60
	Benchmark Passage C-6	8
	Test C-6	10
	Man Eaters of Kumaon	35
	Quiz	5
	Break	10
	Man Eaters of Kumaon	48
	Quiz	5
	Questionnaire	15

APPENDIX A

	Material	Elapsed Time
(Day 4)	How to Win Friends and Influence People	50
	Quiz	5
	Break	14
	How to Win Friends and Influence People	47
	Quiz	6
	Break	13
	How to Win Friends and Influence People	33
	Break (lunch)	64
	How to Win Friends and Influence People	16
	Quiz	3
	How to Win Friends and Influence People	31
	Break	15
	How to Win Friends and Influence People	16
	Quiz	4
	Run Silent, Run Deep	24
	Break	11
	Run Silent, Run Deep	54
	Break	10
	Run Silent, Run Deep	39
	Quiz	6
	Break (dinner)	70
	Benchmark Passage C-7	8
	Test C-7	10
	Run Silent, Run Deep	30
	Break	15
	Run Silent, Run Deep	50
	Break	5
	Run Silent, Run Deep	17
	Quiz	15
(Day 5)	Run Silent, Run Deep	45
	Break	10
	Run Silent, Run Deep	60
	Quiz	10
	Break	18
	America's Race for the Moon	31
	Break (lunch)	65
	America's Race for the Moon	18
	Quiz	6
	America's Race for the Moon	31
	Break	12
	America's Race for the Moon	8
	Quiz	5

APPENDIX A

Material	Elapsed Time
Riders of the Purple Sage	29
Break	15
Riders of the Purple Sage	27
Quiz	4
Riders of the Purple Sage	18
Break	9
Riders of the Purple Sage	38
Quiz	6
Break (dinner)	70
Benchmark Passage C-2	8
Test C-2	10
* Benchmark Passage C-3	8
* Test C-3	11
Riders of the Purple Sage	20
Break	10
Riders of the Purple Sage	61
Quiz	5

* repeat of pre-experiment measure.

FINAL REPORT

PART 3

Project No. 5-0801
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FURTHER RESEARCH ON SPEEDED SPEECH AS AN EDUCATIONAL MEDIUM--THE USE OF LISTENING AIDS

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Bureau of Research

FINAL REPORT

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Further Research on Speeded Speech as an Educational Medium --The Use of Listening Aids

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Introduction

This progress report is one of a continuing series of reports devoted to research on variables associated with the comprehension of time-compressed speech. Compressed speech is produced by a device which permits the presentation of tape recordings in a shorter time than the recording time, without distorting the pitch. This is accomplished by the electronic deletion of very minute segments of the tape record, with the remainder of the record being abutted together.

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Research has indicated that the potential use of connected discourse which is presented faster than normal, but which is just as intelligible as normal speech, is great. Concurrently, interest in compressed speech has been growing at an accelerating rate. Within the past year, the technique has received considerable publicity at professional meetings, in the press, and on television. This growing interest has taken two major directions: The application of compressed speech in situations demanding a high output of information in restricted time; and in the examination of basic problems in listening research for which this technique provides a unique means of varying the temporal aspect of speech while holding other variables essentially constant.

Previous reports of research on compressed speech at the American Institutes for Research have described a series of experiments in which college students were tested on their comprehension of connected discourse following a variety of different types of practice in listening to compressed speech. A number of different treatments have been examined in previous experiments in which the main variables have been the amount of exposure, the duration of continuous exposure, and the speed of presentation of the practice material. The major findings may be briefly summarized in the statement that the experimental subjects had little or no difficulty in understanding compressed speech at or below 300 words per minute (wpm). Beyond that point some loss of comprehension is experienced initially, but the amount of that loss may be decreased with practice. In all cases there has been significant mean improvement at rates of 425 and 475 wpm with exposure to compressed speech as compared to a control group with very little exposure. However, at such high rates of speed, performance remained well below the level of comprehension at normal recording speed (175 wpm). (For more detailed discussion of these findings, see Progress Reports 1 and 2 in this series.)

The Listening Aid Study

In previous experiments performance has been examined under conditions which provided the listener minimal preparation for the content of the material; training was centered exclusively on exposure to appropriately speeded material. In the experiment reported here, preparation for the content of the material was employed in conjunction with practice in speed listening. In this experiment two means of preparing the subjects for the material to be presented were studied. A written summary of the material to be heard was presented to one group, while a list of key words in the passage was presented to another group. A third group (the Control group) received no listening aids prior to exposure. The major hypothesis was that relative to the performance of a control group which did not receive them, these listening aids would improve performance during training and that this improvement would generalize to performance on a new passage presented without any listening aids at the end of the experiment.

Rationale

In listening to compressed speech several factors play a major role, and it may be assumed that others play a minor role. The primary factor is the rate at which input is made to the listener. We have explored the range of speeds from 325 to 475 wpm, or, approximately two to three times the original recording speed. While practice listening has been found to improve performance, the higher the speed (in this range) the poorer comprehension is likely to be. Because there is less time to process the input, it is to the listener's advantage to recognize as quickly as possible words and phrases in the presentation. It is now well known that the fewer alternative stimuli which may be presented, the quicker will recognition response be. It was hypothesized that preparing the subject for material which may be presented will reduce the number of alternatives, thereby providing a listening advantage to the prepared subject. It was proposed, therefore, to prepare the subject in two different ways: by providing a summary of the content of the forthcoming passage without emphasizing the particular language in which it was expressed, and by preparing the subjects for unfamiliar (high information carrying) words to be heard in the passage. The performance of these two groups of subjects, at moderately high speed (375 wpm), was compared with that of a control group with no preparation.

Because of previous, primarily introspective evidence, which suggested that the best listening technique for compressed speech involved attention to larger units than one word, it was felt that the group which received the summary would have some advantage over the "key word" group.

Procedures

Subjects. The listening aid study employed 22 male college students (four freshman, nine sophomores, seven juniors, and two seniors). The subjects ranged in age from 18 to 25 years with a mean age of 19.9 years. Eighty-six percent of the subjects had spent the majority of their lives on the East Coast, principally in and around the District of Columbia metropolitan area. All of the subjects attended a local university with 41% in arts and sciences, 27% in business and public administration, 14% in college of engineering, and 18% in college of education. The average letter grade of the subjects for their last semester in college was C+.

None of the subjects spoke a foreign languange fluently. Ninety-one percent had never had any form of rapid reading training, the remainder having had a short high school course. None had had any rapid listening training.

The subjects estimated that they could assimilate approximately 62% of their college course work without recourse to reading about the material. Seventy-seven percent stated that they would prefer more time devoted to lecture and less to reading in their course work, while the remainder held the opposite opinion.

Subjects were paid approximately $1.50 per hour plus $1.00 carfare per session. They were told that one subject in each of the three groups would be awarded a $10 bonus based on performance.

Material. Listening materials consisted, as in previous experiments, of two kinds: Eight historical passages of about 3500 words taken from a single college level textbook on English history in the period of colonial settlement.[1] They were recorded on magnetic tape and compressed to a speed of approximately 375 wpm. For each of the passages, a five-option multiple choice test of 25-30 items was developed and standardized on a similar student population. In addition, a precis (about 170 words long) of the passage content, and a list of the key words in the passage (a mean of 128 words per passage) were also produced. The second type of material was used for listening practice and consisted of a single novel

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[1] Notestein, W. The English people on the eve of colonization, 1603-1630. New York, Harper & Bros., 1954.

(Run Silent, Run Deep)[2] recorded on magnetic tape and compressed to a speed of 375 wpm.

In addition to the above materials, a biographical data sheet and a debriefing questionnaire were also used. At the end of the experiment, a battery of psychological tests selected from those developed by Project TALENT[3] was administered, and a measure of simple reaction time taken.

The equipment consisted of the following: one Tempo Regulator, one Magnecord tape recorder, one Bogen amplifier, two Eltro-Voice speakers, and ancillary wiring. A reaction timer consisting of Decade Interval Timers Model 100 C, Series D, and Model 120A KlockKounter was also employed. The experiment took place in a sound deadened laboratory in which the students were seated as in a classroom. The tape recordings were presented free field.

Design. The basic design called for an initial measure of performance at normal recording speed (175 wpm) for purposes of establishing a base line and for dividing the 24 subjects into three matched groups. Besides this initial measure, subjects also completed a biographical data sheet, a pay voucher, and were given a pure-tone audiometric screening test to ascertain whether any subjects had to be rejected on grounds of having a marked hearing loss (none were rejected). On the basis of initial normal speed comprehension scores, the 24 students were divided into three groups with equivalent mean scores. These groups were designated the Precis Group, the Key Word Group, and the Control Group. Subsequently, one subject each was lost from the Precis and Control Groups due to failure to complete the experiment for personal reasons.

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[2] Beach, E. L. New York: Holt, Rinehart & Winston, 1955.

[3] Flanagan, J. C., Dailey, J. T., Shaycroft, Marion, Gorham, W. A., Orr, D. B. & Goldberg, I. Design for a study of American youth. Boston: Houghton Mifflin, 1962.

The experiment proper was begun on a Monday and was run in seven days (exclusive of the weekend). Each session lasted approximately one and one-half hours. The first session was devoted to the initial measurements. Each of the next five sessions followed the pattern described below. Approximately 50 minutes of *Run Silent, Run Deep* was presented at 375 wpm, followed by a ten-minute break. After the break the Precis Group subjects were each given a typewritten summary (about 170 words in length) of the passages to follow. The Key Word Group subjects were each given a list of about 130 words consisting mostly of proper nouns and unusual words to be found in the forthcoming test passage. The remaining (Control Group) subjects were instructed to sit quietly and were given no listening aid. Subjects in the first two groups were allowed to scrutinize the listening aids for two and one-half minutes, after which the listening aid was removed and the test passage presentation begun. At the conclusion of the passage all subjects were given a multiple choice comprehension test based on information in the passage.

On the seventh day of testing, all subjects again listened to approximately 50 minutes of *Run Silent, Run Deep* at 375 wpm and were then given a ten-minute break. A passage and test was then presented to all subjects; however, in this case, *no one* received any listening aid. This was intended to measure generalization of performance to a new passage for which there was no immediately prior preparation. After this test, each of the three groups was divided into two sub-groups matched for current proficiency with compressed speech. The matching was done by combining the scores for the previous two sessions' testing as the best indicators of their abilities to date. One-half of each of the three groups was then given a precis while the other half was given nothing. The comprehension test based on the passage was then given, *but no passage was presented.* The purpose of this measure was to examine to what extent information in the precis might have contributed to performance on the tests.

Subjects were then paid and thanked for their participation but were asked to return for two more sessions during which a selected group of tests taken from the Project TALENT battery of psychological tests were administered in an effort to find skills which might be highly correlated with proficiency at listening to compressed speech. For the same reason, a measure of simple reaction time was also taken. The reaction time measure was taken in the following way for 20 of the 21 subjects who took the Project TALENT battery. (One subject failed to stay for this measure.) Subjects were taken individually and told that after they hear the ready signal to watch the stationary light in the counter. After short but irregular intervals of time, that light would begin to move. As soon as the light moved, they were instructed to press the button on which their finger rested. Each subject was given five practice trials. The duration of the delay between ready signal and light movement was randomized but presented in the same sequence for all subjects. Fifteen subjects received twenty trials, the remaining five received ten trials because of lack of sufficient time. The mean duration between onset of light movement and button press was taken as the subject's reaction time.

Results

Table 1 shows the group means and the order of presentation of the passages. Percentages were compiled by using each subject's normal speed score as his own base. Performance on the base line passage presented at 175 wpm was similar to that of subjects in previous experiments. The mean score for the 22 subjects who completed the experiment was 14.3 based on a 25-item test, corrected for guessing, as compared with overall mean score of 15.1 for 102 previously tested subjects.

Table 1

Mean Listening Test Scores[a] and Mean Percentages of Normal Speed Scores by Group and Rate of Presentation in Order of Presentation

Subject Group	Word Rate Per Minute and "C" Passage Designation								
	175	375	375	375	375	375	375	No Passage[c]	
	C-1	C-7	C-8	C-6	C-3	C-2	C-4[b]	C-5[d]	C-5[e]
Precis (N=7)	14.1	7.6	12.2	12.0	10.2	12.4	11.8	4.8	6.2
%	100.0	55.6	93.6	90.4	72.9	90.2	91.6	39.0	39.2
Key Word (N=8)	14.4	8.2	10.2	10.3	9.2	11.5	13.2	8.0	3.0
%	100.0	57.1	80.7	82.4	62.6	83.1	97.5	55.6	22.2
Control (N=7)	14.3	8.2	10.6	11.4	11.6	14.0	12.9	5.6	7.0
%	100.0	60.9	82.8	87.6	81.3	108.4	88.6	50.0	27.7
All Subjects (N=22)	14.3	8.6	11.0	11.2	10.3	12.6	12.7	6.2	5.3
%	100.0	57.7	85.4	86.6	71.8	93.4	92.8	48.0	28.8

[a] Scores were prorated to a base of 25 items and corrected for guessing.

[b] This passage and test was administered to all subjects without any listening aids.

[c] Approximately one-half of each group is represented in each column.

[d] All subjects in this column received a precis prior to the test.

[e] No subjects in this column received any listening aids prior to this test.

The differences in means between the three groups on the five days during which listening aids were presented were small, and not statistically significant, according to a two-factor analysis of variance; contrary to the predictions made. Table 2 presents the summary ANOVA.

Table 2 shows that, while the groups do not differ from each other, there was a significant tendency to improve with practice (p is less than .01). For each of the groups the best mean score was achieved on the last of the five tests, the poorest mean score on the first. The combined means were: 8.6, 11.0, 11.2, 10.3, and 12.6, respectively for the five practice tests in order across time.

On the seventh day of the experiment, the test passage was administered at the same point in the session except that none of the subjects received any listening aid. Again, no significant difference among the group means obtained. The respective means scores for the Control, Precis, and Key Word Groups on this test were: 12.9, 11.8, and 13.2 with a combined mean of 12.7. These may be compared with the base line scores at normal speed for the three groups, which were: 14.3, 14.1, and 14.4, respectively, with a combined mean of 14.3. Although the final test (at 375 wpm) scores were lower than the initial test scores at normal speed, the difference did not reach significance at the .05 level.

The final test of the experiment, also administered on the seventh day, consisted of the presentation of a precis to one-half of the subjects in each group, with no listening aid supplied to the remaining half. This procedure was designed to see if the precis provided a significant impact on the number of questions answerable without recourse to the passage. Therefore, no passage was presented. The mean score on this test for the combined one-half of the subjects who received the

Table 2

Summary ANOVA Groups by Five Tests

During Listening Practice

Source of Variation	df	Mean Square	F
Between Ss	21		
Groups	2	1.47	
Within	19	28.91	
Within Ss	88		
Tests	4	61.71	6.46**
Groups x Tests	8	4.43	
Tests x Within Ss	76	9.55	

**p < .01

precis was 6.2, while that for the other half was 5.3, a non-significant difference. This finding suggests that the information provided in the precis was non-specific enough that it did not bias the score obtained by the Precis Group by providing them answers to the questions independent of listening to the passage.

In examining the significant improvement of the subjects with practice, the scores may be looked at in relation to the normal speed listening scores. There was a strong tendency to show improvement with successive sessions. The mean percentages of normal speed performance from the second through the sixth day were as follows: 57.7, 85.4, 86.6, 71.8, and 93.4. Performance on the final passage at 375 wpm administered on the seventh day was 92.8% of normal speed score. Figure 1 shows these data.

These results compare favorably with any achieved in previous experimentation at that speed. Table 3 shows the percentages of normal speed score achieved by previous subjects on the last new passage administered at 375 wpm. Performance of the subjects in the present experiment ranged from 9 to 22 percent better than that of previous groups at this speed. This was achieved with less listening practice than any previous experimental group.

The current experiment combined certain features of previous experiments which may have led to this advantage: Sessions were approximately one and one-half hours in length; they were held daily, the proportion of time devoted to listening to test material as opposed to practice material was greater than for previous experimental groups; and the duration of constant listening was approximately 50 minutes without interruption. The material was all presented at one speed (375 wpm), intermediate between normal (175 wpm) and high speed (475 wpm).

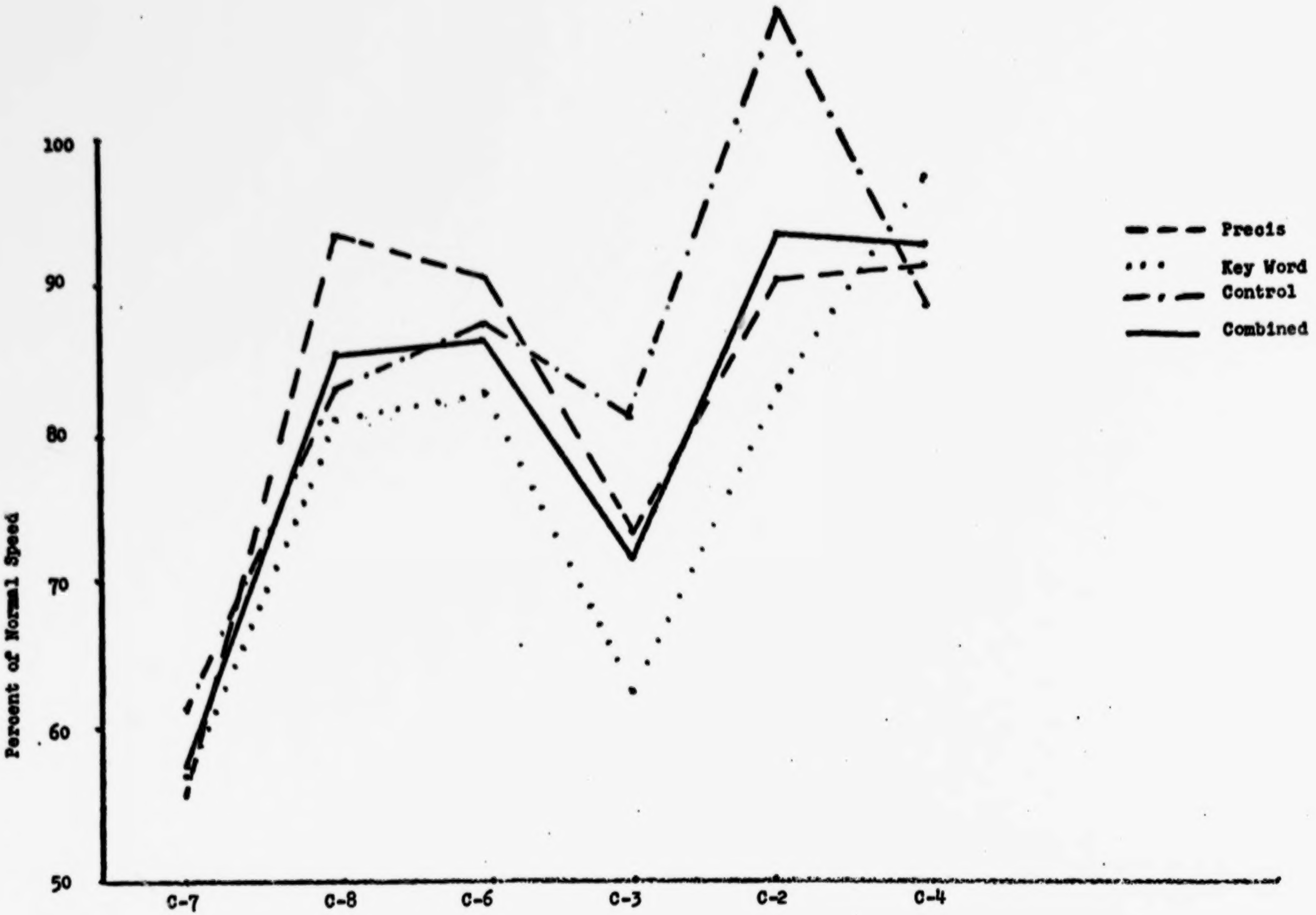

Fig. 1 Mean percentages of normal speed comprehension for five passages with listening aids and one without (C-4).

Table 3

Comparison of Comprehension Results at 375 Words Per Minute as a Function of Practice for Seven Groups of Subjects

Group	Mean Scores			Hours Listening Practice Prior to 375wpm test	
	175 wpm (Normal)	375 wpm	% Normal	Novels	Passages
Control (N=11)	17.4	12.7	71.7	0.00	0.50
Graduated Practice (N=10)	15.7	13.2	83.6	9.00	0.50
Interrupted Practice (N=11 Males)	14.1	9.4	71.0	9.00	0.50
Interrupted Practice (N=15 Females)	13.9	10.1	75.1	9.00	0.50
High Speed Practice (N=12)	13.8	9.9	76.0	9.00	0.50
Criterion Study (N=10)	15.5	11.9	77.2	15.25	0.75
Present Study (N=22)	14.3	12.7	92.8	5.00	0.75

Comprehension of Compressed Speech as a Function of Other Skills. From time to time questions have arisen as to the characteristics of students who do well in compressed speech studies. While the present experiment was not specificually designed to answer this question, it was decided to collect data which may be relevant in this respect. To this end a battery of information and aptitude tests was administered to the subjects. The results were analyzed in two ways: by computing correlations between the test scores and listening comprehension scores; and by plotting mean test scores as a function of high, medium, and low listening comprehension scores.

Correlation Data. These data are shown in Table 4. Correlations were computed between tests in the battery and:

(1) initial, normal speed comprehension score;

(2) initial, fast (375 wpm) comprehension score;

(3) final (after five days of practice) fast (375 wpm) comprehension score.

Means and standard deviations are also presented for the test battery data.

It is clear from these data that the degree of relationship between listening test performance and the aptitude and information test scores was generally rather low. The highest relationship (social studies information vs. initial fast speed) may be explainable in terms of the fact that the test passages were based on historical material, thus perhaps giving some initial advantage to persons versed in the social studies area.

In general, however, those seven correlations reaching a significant level with normal speed listening suggest that the successful listener was bright, well-informed, and able to discern the way that

Table 4

Correlations and Summary Data for Project TALENT Tests Versus Selected Listening Comprehension Scores (N=22)

Test	Passage and Word Rate				
	Normal 175	First 375	Last 375	$\overline{X}$	s
Information Tests					
Vocabulary	.37	.29	.63	18.7	1.24
Literature	.49	.44	.47	19.2	1.74
Music	.30	.32	.01	9.2	2.36
Social Studies	.50	.71	.36	20.4	3.28
Mathematics	.32	.21	.17	19.5	3.42
Physical Science	.20	.27	-.08	14.7	3.32
Biol. Science	.50	.60	.13	7.9	1.67
Scientific Att.	.20	.04	.04	8.5	1.44
Aero. & Space	.54	.14	-.12	8.6	1.69
Elec. & Elec.	.56	.28	.08	14.9	3.62
Mechanics	.24	.01	.07	15.7	2.35
Farm & Ranch	.20	.06	.19	8.9	1.32
Home Economics	.11	.21	.30	10.3	3.46
Sports	-.17	-.13	.00	11.1	2.19
Total Score	.34	.44	.25	199.3	20.86
Aptitude Tests					
Arith. Comput.	.42	.12	.26	43.5	11.06
Mem. Words	.00	-.28	.16	15.0	6.22
Mem. Sentences	.07	-.43	.25	10.3	2.11
Math. I	.21	.15	.04	14.0	2.04
English Usage	.13	.02	.20	19.4	1.86
English Expression	.10	.04	.44	10.6	1.07
Abstract Reason.	.37	.12	.00	11.3	1.88
Mech. Reason.	.08	-.07	.15	16.6	2.78
Disguised Words	.03	.31	.02	22.1	5.66
Vision 3-D	-.04	.09	.20	10.7	3.66
Word Function	.49	-.04	.21	16.5	4.24
Reaction Time	-.18	.09	-.06	.185	.036

P_{05}: r = .42

words function in sentences. The five relationships with initial high speed score give a somewhat similar impression; however, the significant negative relationship with memory for sentences suggests that, at least at initial confrontation with compressed speech, focus of attention on grammatical entities such as sentences is associated with poorer comprehension.

At the final stage there were only three significant correlations with listening score: vocabulary, literature information, and English expression. Thus after practice, success in comprehending rapid speech appears to be clearly associated only with a language ability factor, thereby suggesting that, when the task of listening is difficult, but the listener is skilled, general language abilities are the most crucial.

Mean Plots. To gain further understanding of the relationship of the listening comprehension scores, the data were plotted as follows: The total group of subjects (N=21) was divided into approximate thirds on the basis of the listening comprehension score; the mean Project TALENT test score was computed for each third (high, medium, and low); these means were referred to Project TALENT data[4] for 12th grade males; differences from the Project TALENT means in terms of Project TALENT standards deviation units were plotted by high, medium, and low groups for each Project TALENT test. This procedure was employed for thirds based on initial (normal speed) score, initial high speed score, and final high speed score. The data are shown in Figures 2, 3, 4, 5, 6, and 7.

These plots, being based on very small groups of subjects (6-9 each), provide tentative descriptive data and are included here

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[4] Flanagan, J. C., et al. The American high school student. Pittsburgh: University of Pittsburgh, 1964, Pp. 2-47, 48.

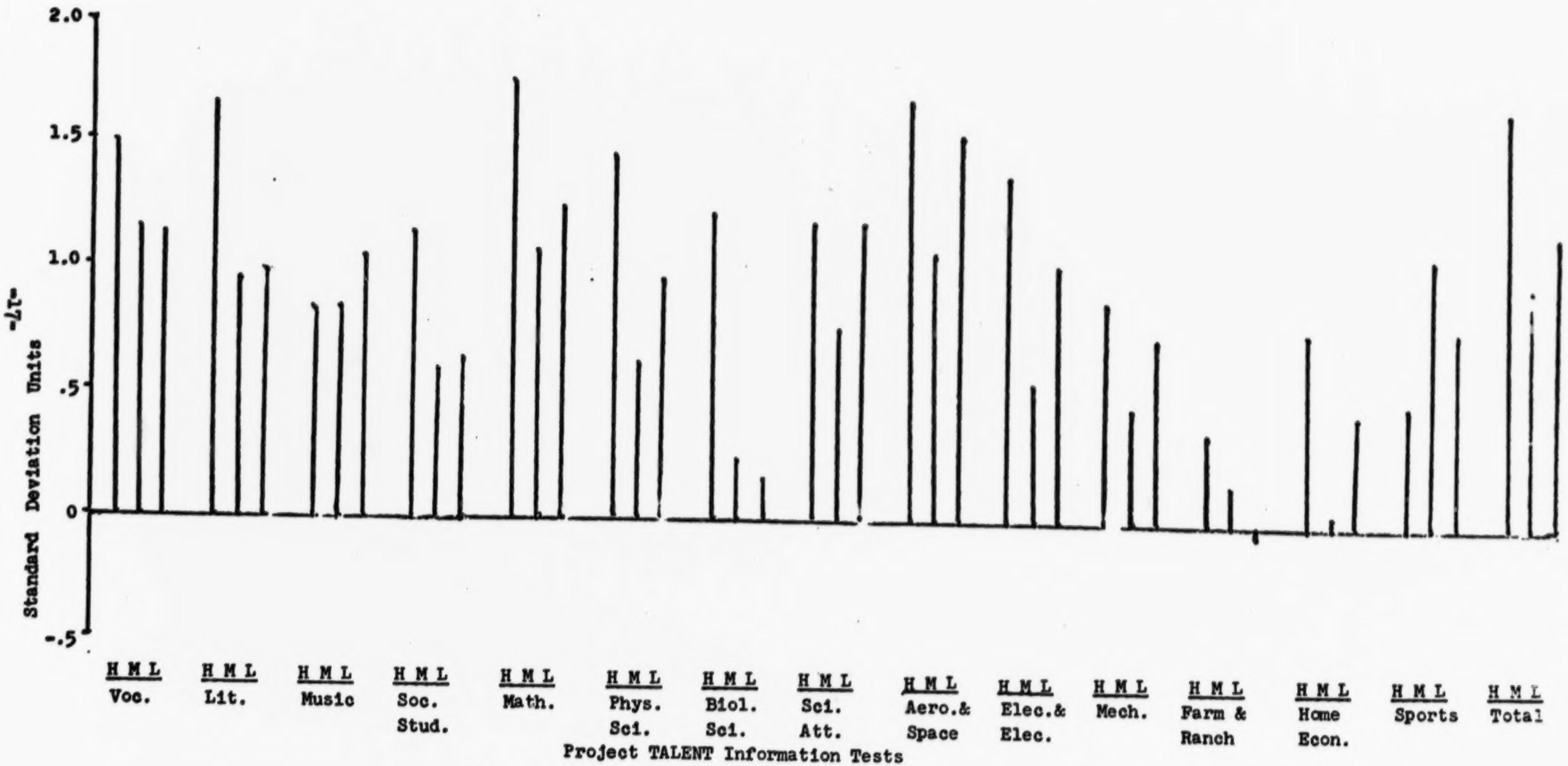

Fig. 2 Comparison of means for High, Middle, and Low thirds on the initial, normal-speed listening comprehension test (C-1) in terms of Project TALENT information means and standard deviation units.

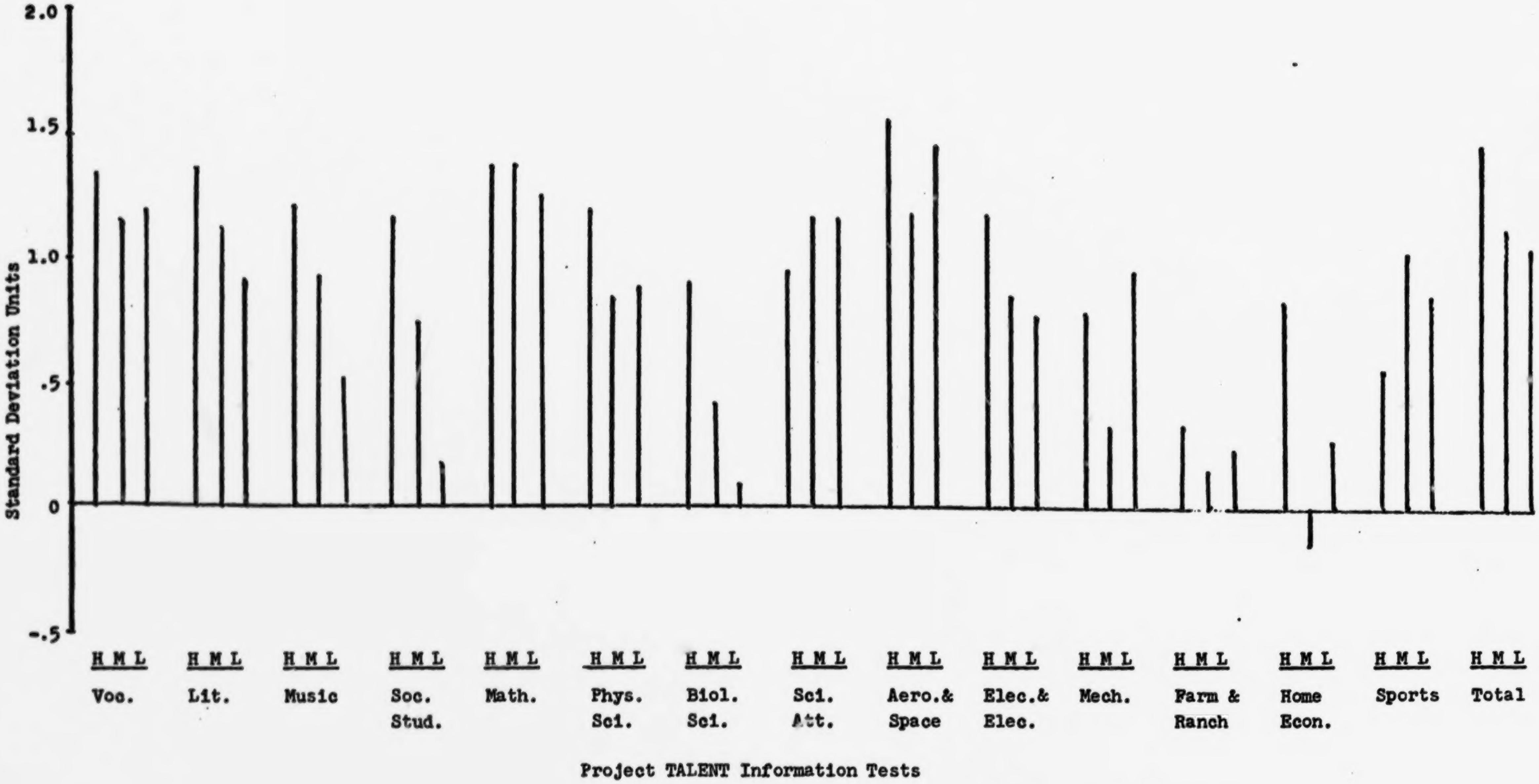

Fig. 3 Comparison of means for High, Middle, and Low thirds on the initial 375 wpm listening comprehension test (C-7) in terms of Project TALENT information means and standard deviation units.

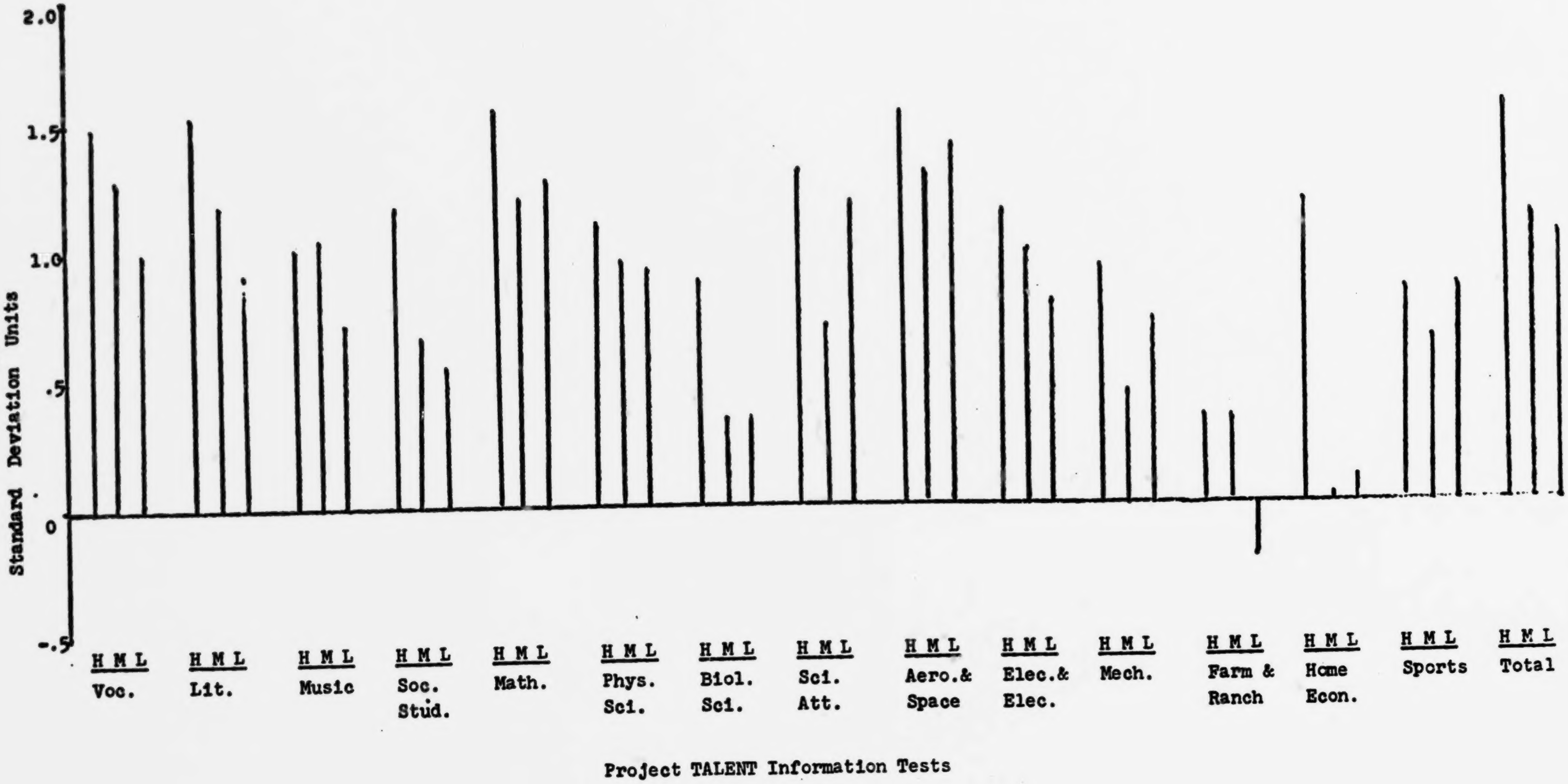

Fig. 4 Comparison of means for High, Middle, and Low thirds on final 375 wpm listening comprehension test (C-4) in terms of Project TALENT information means and standard deviation units.

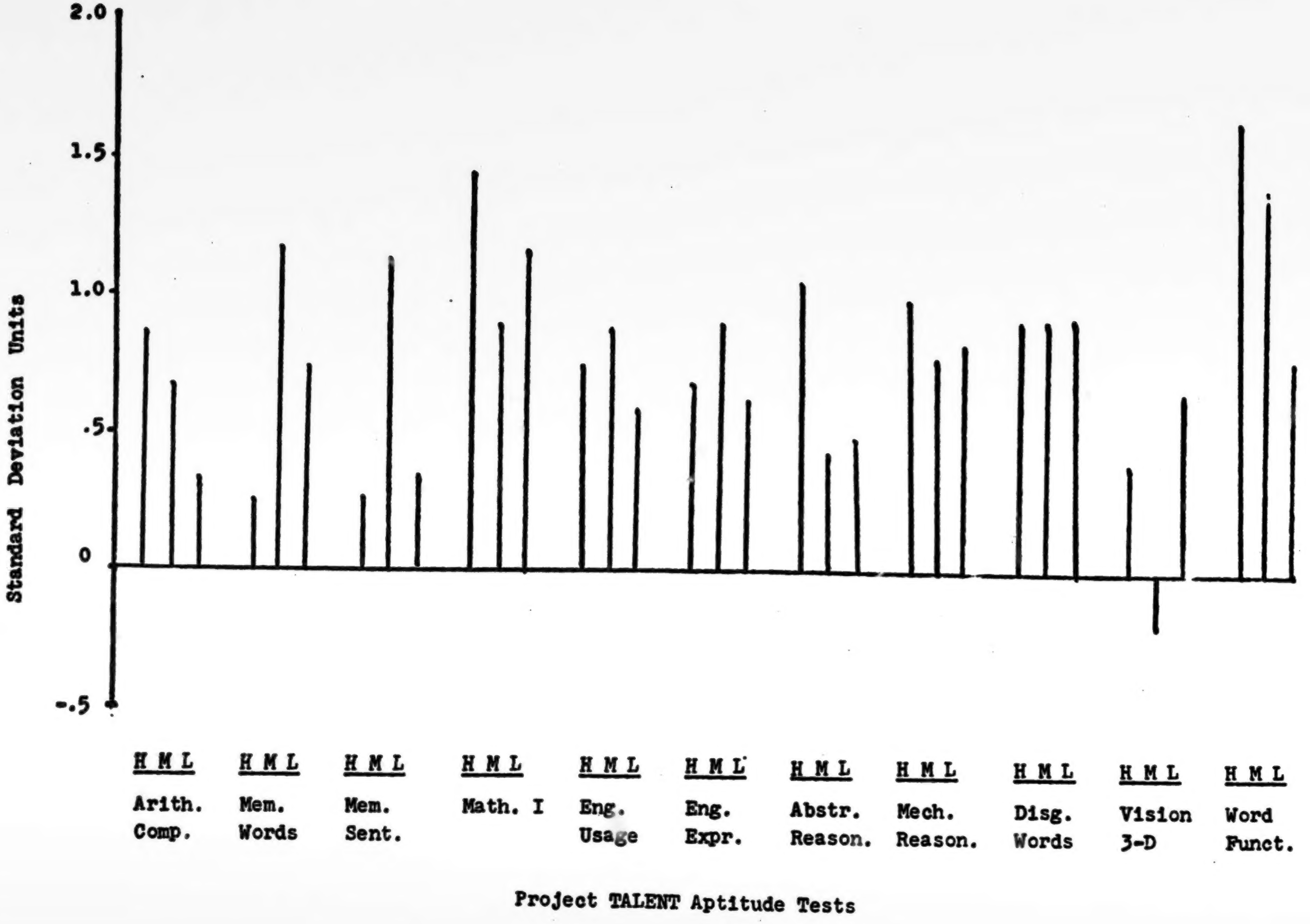

Fig. 5 Comparison of means of High, Middle, and Low thirds of initial, normal speed listening comprehension test (C-1) in terms of Project TALENT aptitude means and standard deviation units.

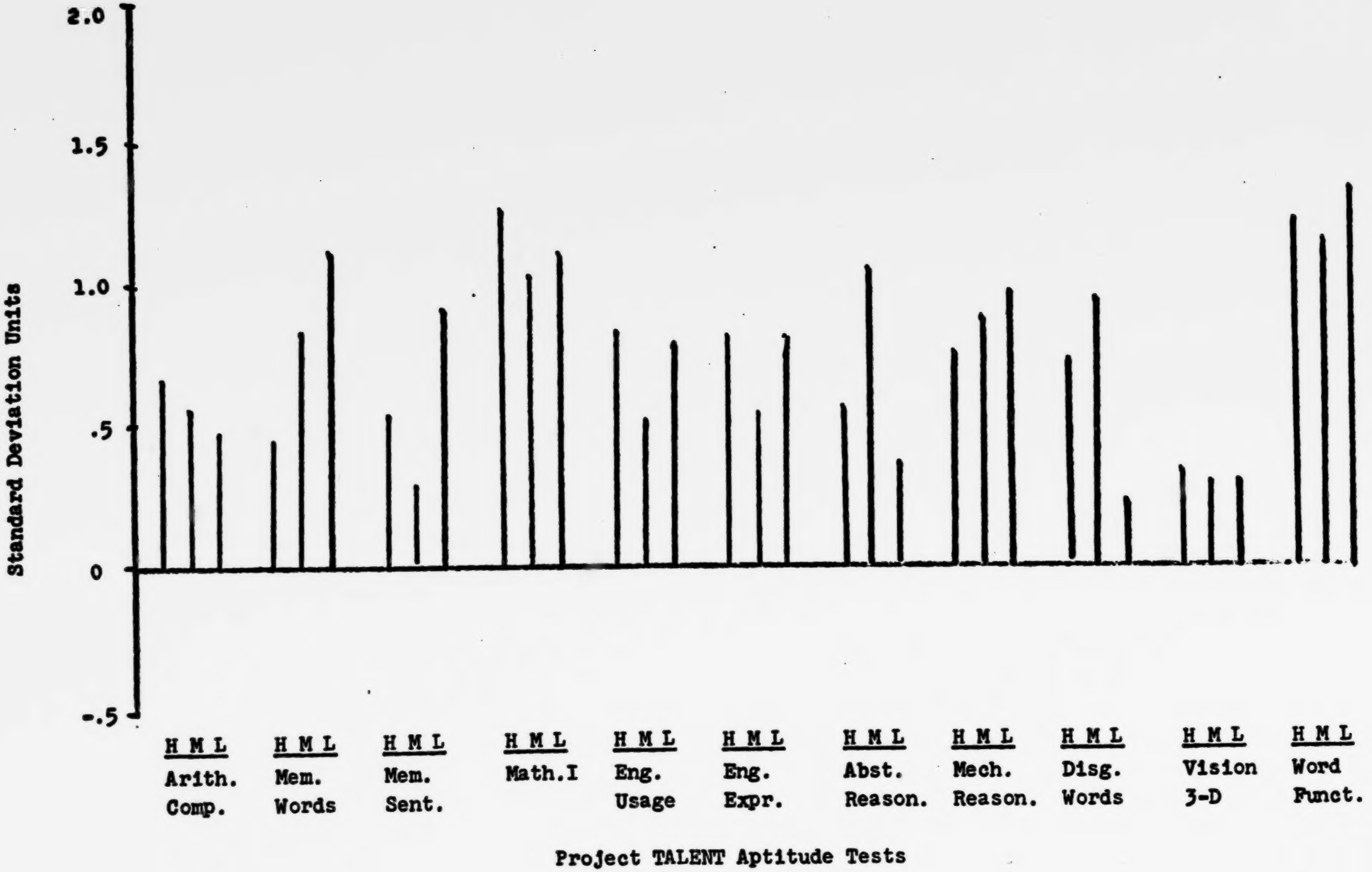

Fig. 6 Comparison of means of High, Middle, and Low thirds of initial 375 wpm listening comprehension test (C-7) in terms of Project TALENT aptitude means and standard deviation units.

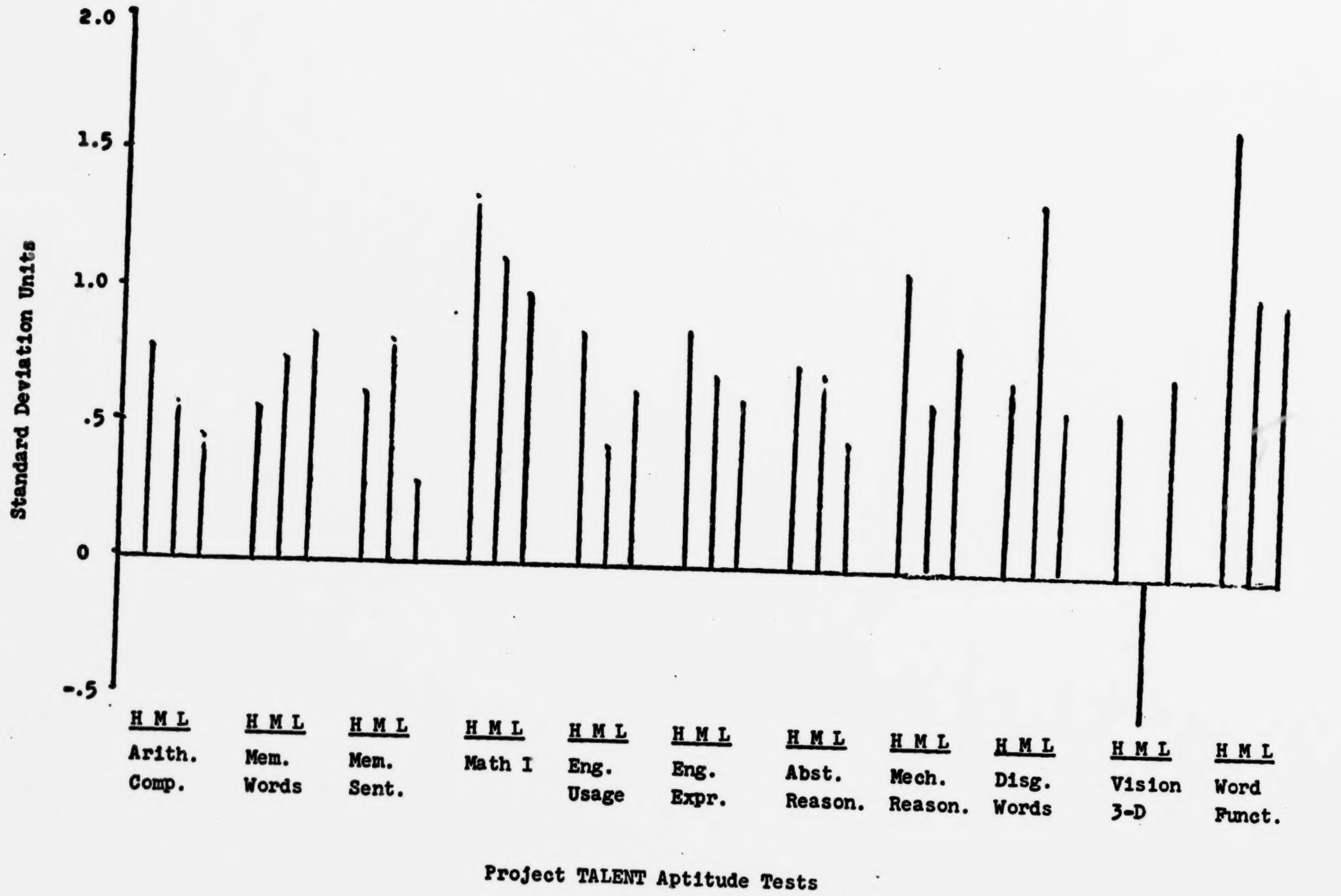

Fig. 7 Comparison of means of High, Middle, and Low thirds on final 375 wpm listening comprehension test (C-4) in terms of Project TALENT aptitude means and standard deviation units.

only for general interest. A few observations may be made about them, however.

With respect to the information tests there was a clear tendency for the normal speed high group to be highest on the Project TALENT tests. Differences among H, M, and L groups tended to be reduced at the initial high speed stage though Music, Social Studies, Biological Sciences, and Home Economics information still clearly separated the groups. At the final high speed stage, the H group was distinguished primarily on Social Studies, Biological Sciences, Home Ecnomics, and Total Information scores. The relative positions of H, M, and L groups fluctuated from stage to stage, often as a result of fluctuation of the position of the M group.

With respect to the aptitude tests, the normal speed high group clearly excelled only with respect to Math; and, in several cases, notably Memory for Sentences and Words, the M group surpassed both H and L groups. At the initial high speed stage the H group again was not clearly outstanding, the M group was highest in Abstract Reasoning, and the L group was highest on the two memory tasks. At the final high speed stage, the H group is characterized by high performance on Mechanical Reasoning and discovering Word Functions in sentences, while the M group stands out with respect to identifying Disguised Words.

In summary, it should again be noted that these data are only suggestive and not definitive. It appears that good listeners were characterized, not surprisingly, by a higher intellective informational capability. Though there were no differences at normal speed, the better listeners at initial high speed tended to be those who excelled at deciphering a message (Disguised Words). After practice (final high speed) the best listeners excelled at detecting Word Functions in Sentences while the second best listeners remained those high on the Disguised

Words task. In this the best listeners resembled the normal speed condition where Word Functions also characterized the better listeners. Specific memory factors seemed to be inversely related to listening score particularly at the first high speed stage, suggesting that excessive attention to detail is possibly antithetical to good listening performance. In general, however, the results supported the findings from the correlations that those skilled in dealing with language (particularly functionally) tended to be the better listeners.

Debriefing Questionnaire. At the end of the experiment proper, the subjects were given a form to complete which called for their evaluation of the experiment and their roles in it. All subjects responded yes to the questions concerning whether or not their abilities to comprehend speeded speech had improved during the experiment and whether or not practice had helped them.

The Precis Group for the most part felt that the summary presented just before each passage helped them listen to the passage by giving them some idea of what to look for. The Key Word Group, on the other hand, had a somewhat negative attitude toward their listening aid. It was generally felt that the key word list encouraged a tendency to listen for specific words at the expense of overall meaning. There was some feeling, however, that the key words provided clues in answering the questions.

The Control Group was asked what techniques of their own they had devised, if any, to improve their abilities to comprehend compressed speech. Five subjects mentioned that they tried to concentrate and comprehend the subject as a whole rather than to dwell on specific items.

In discussing changes that might be desirable, factors of comfort such as better air-conditioning, more comfortable seats, etc., were mentioned. Most subjects felt that concentration was of vital importance and any distraction a hindrance.

The prevalent initial reaction to compressed speech was discomfort at the speed. However, as in previous experiments, a favorable impression soon developed, together with the feeling that the speed was comfortable or would be by the end of the experiment.

Most subjects indiated that their attention did wander at certain times but there seemed to be no systematic explanation for it. In response to the question: "Would you be willing to participate in another experiment?" all 22 subjects responded "yes."

Summary and Discussion

This experiment was designed as a test of the hypothesis that listening aids presented during training would improve performance on compressed speech listening tests. The listening aids consisted of a summary of the material to be heard, presented to one group, and a list of key words in the material to be heard, presented to a second group. A third group acted as a control with no listening aids presented. Two conclusions may be drawn: The listening aids did not significantly affect performance; all groups improved with practice in their ability to listen to compressed speech at 375 wpm. (It should be remembered that the "control" group in this experiment received exactly the same amount of listening practice as the other groups.) The improvement with practice led to a final mean score at 375 wpm which averaged better than 90% of normal speed score and was not statistically different from normal speed score.

The examination of the relationship of listening performance to other aptitude and informational scores suggested that good listeners tend to be generally able and well informed, but that at higher speeds general language ability is increasingly important. The evidence also suggested a tentative hypothesis that good performance at higher speed is associated with listening for meaning rather than concentration on specific words and details.

In general the results reconfirmed previous experimental findings that good comprehension is possible at high speeds and that very modest amounts of practice are efficacious in improving comprehension of compressed speech. The failure of the listening aids to improve performance may possibly be attributable to their focusing attention on aspects of the passage which were irrelevant with respect to the test questions. (It should be noted that the listening aids were carefully designed not to tip off answers to the questions.) In addition to this, they may also have functioned to focus attention more on detail than understanding, thus reducing their effectiveness in accordance with the hypothesis discussed above. Finally, it may be that the overriding factor in learning to comprehend speeded speech is simply developing familiarity with the initially somewhat strange sounds of which it is comprised. (However, the trend in comparing the listening aids means to the control mean does not tend to support such an interpretation.)

In subsequent research it is planned to examine the question of listening aids further. A new experiment is planned in which a mechanical listening aid (a tone superimposed on the tape to call attention to important points) and a modified precis procedure will be compared to a new control group. In this experiment, both listening aids will be designed to call attention to portions of the passage important to answering the test questions (a procedure similar to that employed in actual classroom practice). Specific answers to the questions will not be provided in this fashion, however.

Experimental examination of other methods of improving the comprehension of time-compressed speech is also planned for the future. The present experiment added further weight to the conclusion that practice sessions should be frequent (daily) and of substantial duration (about one hour) without interruption. Such a practice schedule will be retained in the future, but the effectiveness of making the practice material more similar in content to the test material will be examined. An experiment will be run to find out how the student adjusts the speed of presentation to suit himself as a function of practice. The combination of visual presentations with the auditory presentation will also be examined as a method for improving comprehension of time-compressed speech.

The overall results of the studies conducted to date have been highly encouraging with regard to the potential educational vale of compressed speech. It is hoped that this research will spur efforts toward a greater understanding of the complexities not only of compressed speech listening, but of the listening process in general.

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PART 4

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--Effects of Listening Aids and Self-Pacing on Comprehension and the Use of Compressed Speech for Review

February 1967

U. S. DEPARTMENT OF
HEALTH, EDUCATION, AND WELFARE

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Further Research on Speeded Speech as an Educational Medium --Effects of Listening Aids and Self-Pacing on Comprehension and the Use of Compressed Speech for Review

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U. S. DEPARTMENT OF
HEALTH, EDUCATION, AND WELFARE

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Introduction and Background

Since 1963, research has been conducted at the American Institutes for Research investigating factors associated with the comprehension of time-compressed speech by normal college students. This research has been sponsored by the New Educational Media branch of the Office of Education. Its main focus has been on the applicability of time-compressed speech in the educational setting. Time compression is a technique, developed in recent years, which permits a shortening of the duration of tape recorded material by electronically slicing out minute segments of the record, while abutting the remainder together. The frequency with which that slice is made determines the speed with which the speech record is presented. The new effect is faster speech which is not distorted as to pitch, and which essentially preserves the overall intonation pattern.

A review of the literature appears in earlier progress reports and will not be discussed in detail here, but the following points are, perhaps, worth reiterating. The initial impetus for compressed speech research appears to have come from work of Miller and Licklider in which the intelligibility of speech signals was preserved in spite of the fact that considerable portions of the record were absent. Garvey then psysically cut out minute segments of tape recordings for faster playback with good results. Fairbanks developed a device to do electronically what Garvey had done by hand, and once again found that a considerable portion of the speech record could be deleted before severe loss of comprehension occurred. Bixler, Foulke, et al began to examine compressed speech presentation with blind subjects.

The major work in the area of training of comprehension of compressed speech by normal subjects has been conducted by the authors.

The results of this research have been favorable in two major respects: Exposure to compressed connected discourse leads to significant improvement in comprehension; and this mode of presentation of historical and literary material at the college level is acceptable to the vast majority of students (more than one hundred and fifty) who have participated in the experiments to date.

Previous experiments, described in earlier reports, have examined the effects of duration, rate, continuity, and amount of exposure to compressed speech on the comprehension of new material presented in compressed form. Most research has suggested that material recorded at about 175 words per minute when compressed to 250-275 wpm remains completely intelligible. Beyond that point, some loss occurs. With training our best groups have achieved 90-100% mean scores at 375 wpm, and 80% at 425 wpm. Retention of what has been learned via compressed presentation has been shown (within the limits of these experiments) to be at least as good, if not better, than retention of material learned at normal speed. A study designed to examine the effects of preparing subjects for the content of the tape by means of summaries and key word lists did not prove to be effective relative to a control group (although both groups showed significant improvement in comprehension). That study was repeated in modified form and is described in this report. In addition to that the question of self-pacing _vs_. externally-paced presentation is examined, as is the use of compressed speech as a means to review material with which the subject is already familiar. The standardization of new material for a later study to compare the suitability of different types of material for compressed presentation is also described in this report.

Finally, the next steps in the proposed research are described and implications for future research.

Listening Aid Study II

Introduction

In the early studies conducted under this grant, listeners had been prepared for compressed speech listening by variations in the practice listening schedule which included manipulation of the duration, continuity, and speed of presentation of material. While those variables are of significance in the training of listening to compressed speech, there is another which was felt to be of importance, preparation for content of the material to be heard. It is customary, for example, to ask students to read material before coming to class to listen to the lecturer. Because compressed speech directly affects the duration for which a message is played (it is presented in less time) it is hypothesized that part of the reason for a drop in tested comprehension at high speeds is a result of a lack of time to process the material even though there may be sufficient time to identify it. It was further hypothesized that one way to reduce the time needed for overall integration of an auditory message is to shorten the time taken for recognition. By reducing the number of anticipated alternatives it was expected that recognition time would be shortened. This has been shown in earlier research by Miller (1951). In the first Listening Aid Study (see Progress Report #3, July 1966) preparing the listener for the content was attempted by two means: (1) A precis of the material to be heard was presented in printed form to one group prior to presentation, and (2) A list of key words to appear in the passage was presented to another group. A third group acted as control, with no listening aid provided.

The results of that experiment were unexpected. While all three groups showed significant improvement in their ability to comprehend compressed speech at 375 wpm, no statistically significant differences among groups were found. The failure of the listening aids to help performance was taken with a grain of salt. We felt that it was partially attributable to the fact that the precis and key word lists were carefully designed not to provide answers to questions on the test. In doing so we felt we may have diminished their relevance to overall comprehension.

We also considered another possibility, that presentation of the listening aids in this experiment tended to focus too much attention on detail, rather than overall meaning, particularly with regard to the key word list.

A new experiment was designed to retest the potential advantages of listening aids of this type. The precis were modified in such a way as to focus more on the overall meaning of the passage, and point to sections relevant to the questions - while not actually providing answers. The key word list was dropped since we felt it may have caused the listener to listen only for those words. A new listening aid was introduced which provided a short pure tone to indicate crucial sentences in the text. It was hypothesized that this attention gathering device during presentation would seem to highlight relevant sections and make the listener more alert. A new control group was also run.

In addition to the examination of the listening aid question with these subjects, it was planned to use the subjects again following completion of this experiment, in another study to examine the usefulness of compressed speech as a review technique with trained listeners and to measure the degree to which listening skill was retained. This experiment is described in a later section of this report.

Procedures

Subjects. Twenty-five male students from a local university (six seniors, eight juniors, eight sophomores, and three freshmen) participated in the experiment. Their ages ranged from 18 to 24.5 years with a mean age of 20.6 years. The majority of the subjects were born on the East Coast. None had marked regional accents, all spoke English as their native language, and none of the finally selected subjects had marked hearing loss in either ear. Only one subject had had training in rapid reading, none had had any training in rapid listening. Their major subjects represented a cross-section of academic fields.

Subjects were tested in groups. They were paid approximately $1.50 per hour plus $1.00 per session for carfare. Three $10.00 bonuses were awarded, one to a member of each group, the subjects having been informed in advance that bonuses would be given on the basis of performance.

Materials. The listening materials used were identical to materials used in previous experiments conducted under this grant. Seven historical passages were taken from a single college level textbook on English history. Six of the passages were compressed from a normal recording speed of approximately 175 wpm, to 375 wpm. The remaining passage was used at normal speed. For each passage a previously standardized five-option multiple choice test of 25-30 items was used. In addition to this a precis was prepared for each compressed passage. These precis were approximately 250 words long; those for passages with thirty item tests were slightly longer. The precis were so constructed that they focused on the content of approximately nine-tenths of the test questions, without revealing anything about the answers to those questions. The precis were edited for unity and smooth reading. See Appendix A for samples of precis, passage and test. The passage texts were also examined for sentences which were most crucial to performance on the comprehension tests. Immediately prior to 80% of these sentences, a tone was superimposed on one channel of a two channel tape recording.

In addition to the above materials, two passages taken from a book on introductory psychology[1] were recorded at normal speed[2] for presentation during this experiment as well as for later use during the measurement of compressed speech as a review technique for these subjects (discussed later in this report). For these passages five-option multiple choice tests of 40 to 45 items each had been prepared for later standardization and item analysis with a college population. These unstandaridized tests were used for the two psychological passages. Practice material consisted of a "talking book"[3] previously compressed to 375 wpm.

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[1] Miller, George A. Psychology, The Science of Mental Life, Harper & Row New York, 1962, Pp 1-172.

[2] Previously words per minute have been used to calculate a constant normal speed rate; however, the syllable to word ratio has been fairly constant (about 1.4 to 1.5 syllables per word.) The psychology material had a syllable to word ratio of between 1.6 and 1.7. Thus, in order to equate normal speed for these different types of material it was necessary to calculate normal speed on the basis of syllables per minute.

Equipment used consisted of a Magnecord tape recorder, a Bogen amplifier, three Electro-Voice speakers, ancillary wiring, and a pure tone audiometer and head set. The tape recordings were presented free field.

Design. The basic design was essentially a replication of the design used for the earlier Listening Aid Study including order of passage presentation. Following an introduction by the experimenter the subjects completed a biographical questionnaire. An initial measure of performance at normal recording speed (175 wpm) was then taken using one of the historical passages and accompaning test for the purposes of establishing baseline performance and dividing the subjects into three matched groups. In the only departure from the schedule used in the earlier Listening Aid Study two psychology passages were played at normal speed, each followed by a multiple choice comprehension test. Since this was presented before high speed it was felt that this would not interfere with basic design.

These three passages and tests were administered on the first day of testing (a Monday, as in the previous Listening Aid Study.) The experiment was conducted for seven consecutive weekdays. The five subsequent sessions followed the pattern described below: The subjects were divided into three matched groups, one which read the precis immediately prior to listening, one which heard the tone while listening, and a third group (control) with no special treatment.

The subjects were tested simultaneously in two groups; the tone group in one laboratory, and the control and precis groups in another. All groups were reminded that a comprehension test would follow each passage. The tone group was instructed to expect the tone at important points during the passage. The precis group was instructed that the precis was an overall summary of the material they would hear.

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[3] Beach, Edward L., Run Silent, Run Deep, Holt, Rinehart and Winston, New York, 1955, Pp. 364.

During each of the five sessions all three groups listened (with no listening aids) to approximately fifty minutes of Run Silent, Run Deep. This was followed by a ten minute break. After the break subjects in the precis group were each given two and one-half minutes to study a typewritten summary of the passage to follow, while the other subjects sat quietly. All subjects then listened to the test passage at 375 wpm. The tone group (in a separate laboratory)heard a tone just prior to important sections of the passage.

On the seventh day the above procedure was followed except that no subjects received any listening aids. This was done to provide a measure of generalization of performance from previous sessions. In addition to that, each of the three groups was subdivided into two matched subgroups. An attempt was made to match subjects on current proficiency in listening to compressed speech. To this end mean scores on the previous two sessions' tests were used as the matching criterion. One of each pair of subgroups received a precis followed by a test, while the other group received only the test. No passage was presented for these tests. The purpose of this was to confirm that the precis itself was not providing answers to the test. Subjects were then dismissed and reminded that they would be recalled for a later session.

Findings

Before going on to the substantive results of this study, it should be pointed out that the final test on which no passage was given confirmed the experimenter's expectations that the precis did not give specific help in answering test questions. There was no significant difference between the scores of those subjects who received the precis and those who did not on this test, as illustrated in Table 1.

The major hypothesis of this study was that the use of listening aids would improve performance relative to a control group without listening aids. This was not borne out. There was no significant

Table 1

Mean Listening Test Scores[a] and Mean Percentages of Normal Speed Scores by Group and Rate of Presentation in Order of Presentation

Subject Group		Word Rate Per Minute and "C" Passage Designation						No Passage[c]	
	175 C-1	375 C-7	375 C-8	375 C-6	375 C-3	375 C-2	375 C-4[b]	C-5[d]	C-5[e]
Precis (N=9)	14.19	7.69	9.00	6.53	10.56	14.86	9.17	4.85	2.38
Per cent	100.00	54.25	69.65	52.44	86.80	114.84	71.85	45.40	18.84
Tone (N=7)	14.61	7.71	11.18	10.04	10.86	12.56	11.71	4.00	6.12
Per cent	100.00	44.25	73.99	69.44	78.87	89.57	72.09	25.68	46.20
Control (N-9)	14.19	7.28	11.03	8.06	9.81	12.94	13.69	5.25	4.35
Per cent	100.00	46.67	76.34	55.37	71.66	94.09	98.15	38.84	32.19
All Subjects (N=25)	14.31	7.55	10.34	8.06	10.38	13.53	11.51	4.77	4.29
Per cent	100.00	48.72	73.28	58.25	79.13	100.29	81.39	38.28	32.39

[a] Scores were prorated to a base of 25 items and corrected for guessing.

[b] This passage and test was administered to all subjects without any listening aids.

[c] Approximately one-half of each group is represented in each column.

[d] All subjects in this column received a precis prior to the test.

[e] No subjects in this column received any listening aids prior to this test.

difference between the groups according to an analysis of variance.

An additional hypothesis predicted that improvement in performance as a result of the use of listening aids in practice would generalize to performance on a passage given at the end of the experiment without listening aids. This prediction was not confirmed.

A third hypothesis was that all subjects would improve with practice. This proved to be the case according to an analysis of variance. ($F = 18.4602$; $df = 4,164$; $p \angle .001$), the same analysis having shown that no differences between groups existed.

An examination of group mean scores on successive days of practice shows an upward trend with a setback on the fourth day. It should be noted that a setback occurred on the fifth day of experimentation in the previous Listening Aid Study. Since the passage order and other conditions were the same it seems likely that an artifact was responsible for the sharp decline in performance. In this study there was general complaint on the day of the decline that the volume level was set too low. Table 1 and Figure 1 illustrate these results. Apart from this setback for all groups combined, performance expressed as a percentage of normal speed score rose from 49% on the first day of practice to 100% on the last day of practice with listening aids. Twenty-one of twenty-five subjects did better than 80% of normal speed score on this day. On the final day of testing without listening aids, 14 of the twenty-five subjects did better than 80%. This represents a decline in performance, but was not typical of all three groups. Although as noted earlier an analysis of variance showed the differences between groups were not statistically significant, the data are nevertheless highly suggestive on this point. While the direction of change in performance was the same for all groups during the course of listening training, on the final day of testing when the listening aids were removed for all groups, the control group continued to improve while the two experimental groups showed a marked decline, as illustrated in Figure 1.

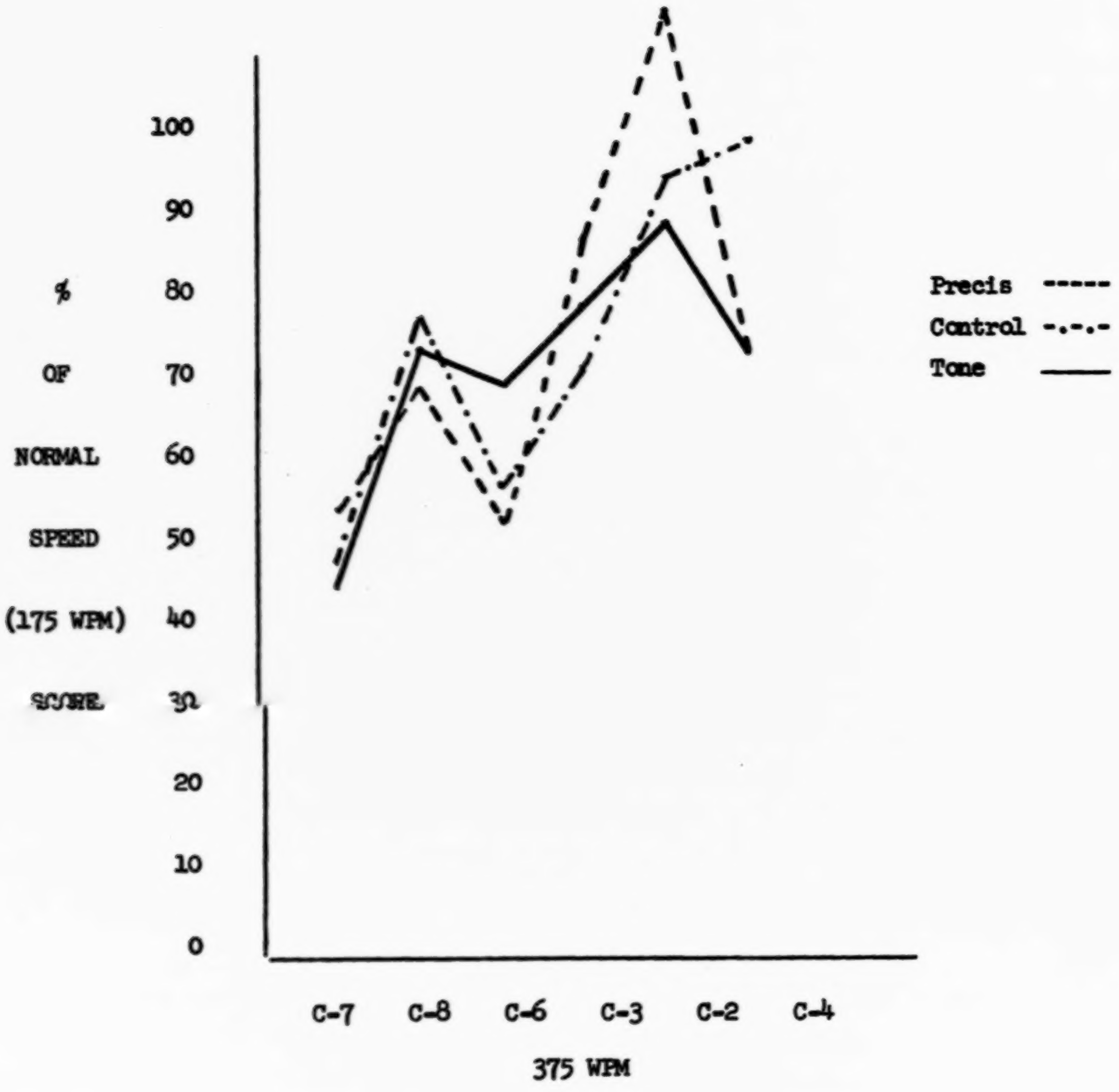

Fig. 1 Mean percentages of normal speed comprehension for five passages with listening aids and one without (C-4).

Performance within groups was examined from the point of view of the degree of relative skill exhibited over time. A coefficient of concordance (Kendall's W) was determined for each of the three groups and showed a significant degree of association in ranking from first through last presentation of the passage tests. For precis, tone, and control groups respectively $s = 1193{,}50$, $w = .406$, $x^2 = 22.74$, $\underline{df} = 8$, $\underline{p} \angle .01$; $s = 940.50$, $N = 7$, $K = 7$, $\underline{p} \angle .01$; $s = 2119{,}50$, $w = .721$, $x^2 = 40.37$, $\underline{df} = 8$, $\underline{p} / .001$. This suggests that relative marks were maintained over time for all groups. A comparison of the current Listening Aid Study with the previous one shows the following:

An analysis of variance performed on the six groups participating in both experiments shows no statistically significant differences among any of them.

Results for all subjects ($N = 47$) were combined. Two tests were performed, one comparing normal speed scores (initial baseline test) with the last listening aid test, and the other comparing it with the last no listening aid test. These tests showed a significant decline from normal to both high speed tests. ($\underline{p} \angle .05$, and $\underline{p} \angle .001$, respectively).

Discussion

The findings of this study are very similar to that of the last one. The predicted boost to listening comprehension provided by listening aids prior and, in one case, during the presentation, did not materialize. While significant differences did not appear between any of the groups, there is at least a suggestion that by the end of the experiment the control groups of both experiments were performing in a superior fashion without listening aids. On the last passage without listening aids the mean score for the control groups was better than the mean score for either of the two groups with which they were matched. On the last test with listening aids, the precis group in the second Listening Aid Study did best with a mean score better than normal speed performance. But the best group under this condition in the first study was the control group; in the second study, the control group did quite well too, achieving 94% of their normal speed scores.

The precis group in the second Listening Aid Study merits some further consideration. Of all six groups, this one alone shows a consistent trend over the last three listening aid passages. Eight of nine subjects show a consistent upward trend over these three passages (the remaining subject drops slightly on the second). The mean score achieved on the last test employing listening aids was 115% of normal speed score, considerably better than any of the other five groups. (It should be remembered that the same order of passage presentation was used for all groups). There is thus a strong suggestion that this group had learned to make good use of their listening aid. As further evidence of this, performance on the next passage presented for which no listening aid was administered to any group, shows a marked decline. Not only did eight of nine subjects show a decrease in score, but the mean score was lower than any of the other five groups on this test. It is suggested that they had come to depend on the listening aid provided.

If this is true, or to put it another way, if the tentative results would have become statistically significant had the experiment continued longer; then a new problem must be dealt with. Preparation for the content of a passage was expected to enhance the speed with which the listener could recognize and integrate compressed speech. It seems likely that practice in using the precis in this experiment in conjunction with listening practice was beginning to have the desired effect. In those groups which failed to benefit from listening aids there is no indication that their withdrawal hurt performance. The groups which seemed to benefit most from the listening aids, suffered most when it was withdrawn.

The evidence in this experiment remains somewhat inconclusive, however, since it is the second experiment of its type and included an attempt to iron out the possible artifacts of the previous experiment, it must be conceded that listening aids of the type employed did not prove to be highly effective.

This raises a larger issue which has been of concern to us for some time. A large number of experiments have now been conducted in listening to time-compressed speech. We have, we think, demonstrated conclusively that exposure to moderately compressed speech will lead to good comprehension with a typical college student population. We have demonstrated that certain schedules of exposure are superior to others and that certain kinds of material lend themselves to compression. However, we have not really begun to identify the basic processes underlying successful listening, or experimented with listener training. We feel that however much a particular listening aid may contribute to listening to specific material, a more important improvement in efficiency might be made in training the listener to use his perceptual and cognitive skills more efficiently for all listening purposes. We believe we have demonstrated the saving in time that can be effected by compressing tape recorded speech. We can present the stimulus more efficiently. We feel the next logical and important step is to train the listener to match this improvement by responding more efficiently. Communication is, after all, at least a two-way process.

Conclusions

The presentation of speech compressed to 375 wpm from 175 wpm for over one hour each day for six days led to significant improvement in comprehension.

Listening scores on the last two passages of the experiment were, however, significantly lower than normal speed comprehension scores.

The use of a precis prior to presentation and a tone (for another group) during presentation to mark important parts of the passage, did not significantly improve performance relative to a control group which did not receive listening aids.

The absence of significant differences between groups held when the groups of this experiment and the previous listening aid experiment (in which a different precis, and a list of key words were used as the listening aids) were compared. There was a tendency for the precis group in this experiment to improve over the last three passages in which the listening aid was employed. This was counteracted, however, by a consistent drop in performance when the listening aid was removed.

When subjects of both experiments were ranked on their performance on each successive passage presentation, there was significant agreement for each group according to a coefficient of concordance.

The Self-Pacing Study

Introduction

Compressed speech is the result of a technological advance which permits an increase in the rate of presentation of tape recorded speech without pitch distortion. In addition to the obvious advantage of being able to communicate orally in less than the normal time required there is a hidden advantage in that rate of speech then becomes a manipulable variable. One of the major differences between communication by speech and communication by print is that in ordinary circumstances the former is externally-paced while the rate at which the latter is perceived is controlled by the individual recipient. Compressed speech not only permits the speeding of oral input, it also allows the rate of speech to be determined by the individual. The research conducted under this and the previous grant has been aimed chiefly at the determination of the ability of college students to comprehend and to be trained to comprehend compressed speech. Because of the desirability of a larger N, experiments have been conducted in groups. While a group experiment doesn't interfere with the experimenter's freedom to present the stimulus at any rate he chooses, it does prevent him from tailoring that speed to the individual, or from having the individual determine his own most comfortable rate of listening. The experiment described here was designed to examine the variable of self-determination of compressed speech rate. Two questions were asked: (1) At what rate will a listener choose to hear material which is compressed? and (2) In what way will this affect his learning to comprehend compressed speech?

Rationale

Evidence exists to suggest that while listening is the preferred modality for young children, and for adults when the material is relatively simple; reading is preferred for older children and for difficult material (Taylor, 1964). The most common explanation offered is that reading permits a perusal of the material at the reader's own rate, and the difficult portions may be reread. It is clear that time, to absorb information, is crucial here. Listening, while it is an earlier learned skill, and may be considered in one way to be more informative than reading because it contains intonational nuances, is handicapped as a mode for the communication of densely presented information because the rate at which listening material is presented is externally imposed. It was therefore felt that an important question to be asked about compressed speech is whether an advantage, in fact, lies in the subject's ability to determine his own rate of presentation.

It was hypothesized that the freedom to determine his own rate of listening would provide a more efficient means of communicating to a subject: efficiency to be measured by the subject's ability to answer questions accurately per unit time taken to receive the information.

Additional questions were: What behavior would result from listener controlled speech? How frequently would the rate be changed? What mean rate would be chosen?

Procedures

Subjects. Twelve male college students (four freshmen and eight sophomores) from a local university were recruited for this study. Their ages ranged from 17 to 20 with a mean age of 19.6. All spoke English as their native language and were born in the eastern part of the United States. The average last semester grade for freshmen was B plus in high school; for the sophomores, approximately B minus in college. An audiometric screening test failed to eliminate any subjects on the basis of gross hearing disorder. No subjects had had any training in rapid reading or listening. Subjects were paid $1.50 per hour for participating plus one dollar per session to cover the expenses of carfare. Subjects were informed at the beginning of the study that a bonus of ten dollars would be paid to the best subject at the end of the experiment.

Materials. Listening materials consisted of seven historical passages taken from a college level textbook on English history at the time of colonial settlement. These passages were professionally recorded at 175 words per minute and compressed on the tempo-regulator to 1.5 times that rate. For each passage, a five-option multiple choice test of twenty-five or thirty questions (which had previously been standardized on a similar population) was used to measure listening comprehension.

Subjects were also given a biographical questionnaire and pay vouchers to complete. Texts of the passages were marked at 30 second intervals, when played at normal speed for use by the E in measuring self-pacing behavior.

The equipment consisted of a tempo-regulator, Magnecord tape recorder, Bogen amplifier, two Electro-Voice speakers with ancillary wiring, and a Zenith A-200 audiometer. An unmarked remote control knob was fixed to the tempo-regulator and the visual dial placed in front of the experimenter not visible to the subject. By turning the knobs in the designated direction the rate of output could be made to increase or decrease. The experimenter could record the rate by the position of the pointer on the dial. Stop-watches were used to time durations of equal passage segments.

Design. Each subject was tested individually in a single session, and served as his own control. A baseline passage at normal recording speed (175 wpm) was administered to all subjects at the beginning of the experiment. Three externally-paced (EP) passages were administered by the experimenter at 1.5 times that speed on the tempo-regulator, and three other self-paced (SP) passages were played back on the tempo-regulator, the rate of presentation being controlled by the listener by means of the remote control knob. Following each passage a multiple choice comprehension test was administered. The order of events is outlined in Table 2.

The same passage was used for all subjects as a normal speed baseline measure. The remaining six passages were used in a different order for each of six subjects according to a Latin square design. This was repeated with the next six subjects.

Subjects were told that they would be listening to several tape recorded passages at speeds greater than normal, after which their comprehension would be tested. After the first break subjects were instructed as follows:

"Now you will listen to another tape. On this tape YOU will

Table 2

Experimental Procedures in Order of Presentation

Order	Procedure	Approximate Time Taken in Minutes
1.	Biographical Questionnaire and Pay Voucher	5
2.	Normal Speed Baseline Passage and Test	32
3.	EP Passage at 1.5 Times Normal Speed and Test	23
4.	Audiometric Screening Test During Ten Minute Break	10
5.	SP Passage and Test	23
6.	SP Passage and Test	23
7.	SP Passage and Test	23
8.	Ten Minute Break	10
9.	EP Passage at 1.5 Times Normal Speed and Test	23
10.	EP Passage at 1.5 Times Normal Speed and Test	23

> be able to control the speed, like so (experimenter demonstrated the direction of increase and of decrease), without changing the pitch. We want you to listen as rapidly as possible without hurting your comprehension, but you may regulate the speed as you wish. If you find the tape too slow, speed it up. If you have speeded the tape too much, slow it down. I mentioned the bonus to you before. In ascertaining which subject will win the bonus not only will we be taking scores on the comprehension tests into account, but also the greatest speeds with which subjects can listen. You will take a test on this passage as you have on the other passages."

Two experimenters recorded data on the self-pacing behavior. Reading from the dial face which indicated the speed of output, one experimenter recorded the rate every time a marked point in the text was reached. As noted earlier, those points represented thirty second intervals in the passage when played at normal speed. The second experimenter also listened for those same points, but recorded the actual time elapsing between points. Thus data was made available on the rate at the end of each successive period, the overall duration, and the mean rate per segment.

Findings

Subjects were first introduced to compressed speech with a tape which was played at 1.5 times the normal recording speed. Following this three consecutive SP passages were presented.

The lowest (mean) rate used by any subject for an entire passage was 1.16 times normal speed; the highest, 2.05. The overall mean speed at which the twelve subjects chose to play the SP passages was very close to the EP speed. (1.45 x normal as compared with 1.50 x normal). For individual subjects there was no consistent trend from first through the third of the SP passages, in terms of the rate at which they were played. The group means were 1.43 (s.d. = .14), 1.45 (s.d. = .18) and 1.48 (s.d. = .24) x normal, respectively. An examination of rate changes within each passage was made.

The passages were divided into approximately equal quarters. Table 3 shows that the differences between successive passages were smaller than those made between successive quarters within passages.

Table 3

Mean Number of Increases and Decreases
in Speed, Per Quarter* for Self-Paced Passages

Passage Order	Direction	Quarter				
		1st	2nd	3rd	4th	All Quarters Combined
	Increase	4.0	2.1	2.2	1.5	2.5
1st	Decrease	.1	1.0	1.0	1.8	1.0
	No Change	5.9	6.9	6.8	6.8	6.6
	Increase	3.8	2.8	2.5	2.1	2.6
2nd	Decrease	.8	.8	1.2	1.3	1.1
	No Change	5.3	7.0	6.2	6.6	6.3
	Increase	3.9	2.8	1.8	1.8	2.6
3rd	Decrease	.8	.9	1.4	1.2	1.1
	No Change	5.3	6.3	6.8	6.9	6.4
	Increase	3.9	2.3	2.2	1.8	2.6
All Passages	Decrease	.6	.9	1.2	1.4	1.0
	No Change	5.5	6.8	6.6	6.8	6.4

* The mean number of readings taken was 10 per quarter; readings per quarter may not add exactly to 10.0 due to rounding.

There was a tendency for the number of upward changes in rate to decline, while the downward changes increased, as the passage went on. For each quarter approximately ten readings were taken per subject. For all passages combined the mean number of changes per successive quarters were as follows: increases 3.9, 2.3, 2.2, 1.8; decreases 0.6, 0.9, 1.2, and 1.4; no changes 5.5, 6.8, 6.6 and 6.8. (See Table 3). It can be seen that subjects made more upward than downward rate changes. It should be remembered that the speed control knob was set at normal at the beginning of each passage.

Comprehension scores on the six passages in order of presentation are shown in Table 4. The scores, expressed as percentages of the normal speed baseline score for each individual were as follows: 76.3, (EP), 79.9 (SP), 74.8 (SP), 90.0 (SP), 77.2 (EP) and 91.1 (EP). The mean percentage of normal speed scores for EP and for SP were identical: 81.6% of normal speed scores. The externally-paced test scores went from 76 to 77 to 91 percents respectively, while the self-paced test scores went from 80 to 75 to 90 respectively.

Since the mean rates selected on the SP passages were approximately equal to rates of the EP passages, it was decided to combine them in an examination of any overall effect in time. Therefore in addition to the examination of raw scores subjects were ranked according to their performance on each of the six passages (from 1, best, to 6, worst) (See Table 5). One might have expected that ranks would get smaller with order of presentation, however this was not exactly the case. The order used was EP, SP, SP, SP, EP, and EP. The mean successive ranks were 3.8, 3.8, 3.9, 3.0, 3.8, and 2.7. The first two in each series had virtually identical ranks, while on the last SP and last EP passage, performance was distinctly better. Thus performance seemed to improve in time within each series.

Within the three self-paced passages, one trend may be noticed. If the rate of presentation and the extent of comprehension (as measured by percentage of normal speed score correct) are ranked for each subject on each of the self-paced passages, the first shows a significant

Table 4

Time Compressed Listening Comprehension for 12 Subjects under Experimentally (E) and Self-Paced (S) Conditions

Pacer	WPM	Mean Score	Mean % 175 wpm (comp.)	Rate (x175 wpm)	Mean % 175 wpm Duration	Index of Efficiency
E	175	15.7	100.0	1.00	1.00	1.00
E	262	11.6	76.3	1.50	.67	1.14
S	250	12.6	79.9	1.43*	.70	1.14
S	254	11.8	74.8	1.45*	.69	1.08
S	259	13.5	90.0	1.48*	.68	1.32
E	262	12.1	77.2	1.50	.67	1.15
E	262	13.8	91.1	1.50	.67	1.34
$\bar{E}$	262	12.5	81.6	1.45	.67	1.22
$\bar{S}$	254	12.7	81.6	1.50	.69	1.18

* Mean rate for 12 subjects.

Table 5

Rank Order of Performance on Each Passage, by Subject

Subject	262.5wpm	Self-paced	Self-paced	Self-paced	262.5wpm	262.5wpm
1	2	5	3.5	6	3.5	1
2	6	1	2	3	5	4
3	6	2	4	5	3	1
4	5.5	5.5	4	2	3	1
5	2	4	3	1	5	6
6	1	4	6	5	3	2
7	4	5	1	2	6	3
8	5.5	1	3	2	5.5	4
9	4	6	5	3	2	1
10	1	2	6	4.5	4.5	3
11	6	4.5	3	2	1	4.5
12	3	5	6	1	4	2
Σ	46.0	45.0	46.5	36.5	45.5	32.5
$\bar{X}$	3.8	3.8	3.9	3.0	3.8	2.7

negative correlation (Spearman rho) of -.63 ($p < .025$ one tailed); the second, a non-significant negative correlation of -.36, and the third almost zero correlation (-.06). (See Table 6 below). Thus, there is a supposition that rate was less important as a determinant of score by the time the third self-paced passage was presented.

Table 6

Correlation between Rate of Listening and
Extent of Comprehension for Self-Paced Passages

	Self-Paced Passage Order		
	1st	2nd	Third
r	-.63	-.36	-.06
t	2.56	1.24	.20
p	.025	NS	NS
df	11	11	11

Mean performance on the final self-paced and final externally-paced passages was lower than mean normal speed score: Self-paced score was 13.5 and externally-paced, 13.8, as compared with normal mean score of 15.7, and these differences approach statistical significance t (SP) = 2.08, df = 11, $.10 > p > .05$; and t (EP) = .190, df = 11, $.10 > p > .05$). Earlier passages were significantly below the mean, so there is some evidence of learning within the two types of presentation. There is no indication of superiority of one method over the other.

Discussion

The two main purposes of this experiment were to examine behavior of compressed speech listeners under self-pacing conditions, and to determine whether in the prescribed circumstances of this experiment self-pacing proved a superior learning method over externally-paced listening.

Listeners were surprisingly modest in the magnitude of changes of rate they chose to make. The mean rate for each of the three passages was very close to the rate at which they first heard compressed speech 1.5 x normal recording speed: Rates were 1.43, 1.45, and 1.48 respectively, suggesting that a matching phenomenon was taking place.

There was no clearcut difference in performance between self- and externally-paced conditions. It is likely that the flexibility provided by the self-pacing switch was not used to full advantage in this brief experiment. The most probable reason is that the listeners used the rate of the initial compressed passage, which was externally-paced to 1.5 x normal, as a sort of standard from which they chose not to deviate very far. Their behavior during self-pacing exhibited a tendency to take the passage up to higher and higher rates during the first quarter, the ratio of increases to decreases grows smaller with each successive quarter. The number of times there was no change was least in the first quarter, but remains fairly constant during the next three.

The fact that the comprehension of the self-paced passages was not considerably higher than that of the externally-paced passages was somewhat of a surprise to the experimenters. The logic behind their expectations was as follows: Under the self-paced condition, subjects were, of course, free to imitate the externally-paced condition; thus they ought to be able to achieve a minimum degree of comprehension which was at least equivalent to their comprehension under the externally-paced condition. Ideally, then, any changes the subjects made ought to enable them to improve their comprehension beyond this minimum. The data did not suggest that this, in fact, was the case.

Logically, there could be two reasons that this did not happen:

1) Comprehension of speech presented at a constant rate is superior to comprehension of speech presented at a variable rate.
2) Subject control of the speech rate could improve comprehension, but some feature of the experiment prevented this.

The experiment produced no data which could eliminate one of these possibilities, but an ad hoc examination of the experimental situation points out some features which might have impeded comprehension on the self-paced passages, or at least not enabled subjects to use self-pacing to its fullest potential. The following are some of these features.

a) Experimental design: Two of the three externally-paced passages followed the three self paced passages, thus the subjects had more training when they listened to those two externally-paced passages. It is possible that if some subjects had continued with self-pacing, their comprehension scores on the last two passages would have been higher than the comprehension scores obtained in this experiment. Another possible manipulation of the experimental design would have been to study self-pacing as a method of training subjects to comprehend compressed speech; it is also possible that if some subjects received all passages under externally-paced conditions, that their comprehension scores on the final two passages would have been lower than those obtained in this experiment.

b) Subjects' understanding of the task: Subjects' may have been manipulating the self-paced passages in such a way as to hurt their comprehension, while thinking that they were actually improving comprehension. Since no feedback was given to subjects concerning their performance on the comprehension tests, this is entirely possible. Perhaps telling the subjects of their comprehension scores after each test, would enable them to find a way to use self-pacing more effectively.

c) Self-pacing as an additional task: The mechanics of controlling their own rate was in itself a task which may have interfered with passage comprehension. The subjects may have concentrated to some extent on doing well at controlling the rate while ignoring their primary task of comprehending the material. It would be expected that with more practice, controlling the rate would require less effort, and thus comprehension on self-paced passages might improve. If this is the case, it might also be expected that if naive subjects were paired so that only one controlled the rate although both listened simultaneously, that early in training, the passive subject might have some advantage over the active (rate-controlling) subject.

Thus experiments should be done (a) to provide more practice in self-pacing, (b) to control the order of self and externally-paced passages, (c) to test the effect of feedback on subject performance and (d) to compare active and passive subjects in a self-pacing situation.

While this experiment provided useful data on the behavior of untrained listeners in self-paced condition, it raised a number of questions that require further attention. Given the state of current technology, self-pacing is of limited practical value since it is not feasible to make available machines for extensive individual use. However, it may be practical to provide a machine for a school library for individual use as an auditory review mechanism for material with which the student is already familiar. This would provide the same flexibility that a reader has in controlling his own rate of reading, with the additional potential advantage of preserving intonational pattern, emphases, and general characteristics of the lecturer's voice. The usefulness of compressed speech as a potential review technique is explored in another experiment.

Conclusion

Performance under self-paced conditions did not differ significantly from performance under externally-paced conditions both with regard to rate of presentation and degree of comprehension.

There was a tendency for subjects to make upward changes more frequently in the earlier part of the passage than later.

Rate of chosen presentation and comprehension score were significantly negatively correlated on the first self-paced passage, showed a negative (but insignificant) correlation on the second self-paced passage, and showed zero correlation on the third.

Both under self-paced and externally-paced conditions comprehension improved with practice, but practice under each of the conditions seemed to be most effective for that condition.

The Standardization of Psychological Test Material

Introduction

During the course of experimentation under this and the previous grant, two types of listening materials have been employed; test material which consisted of edited chapters from a college level textbook on English history; and practice listening materials from pre-recorded popular novels produced by the American Printing House for the Blind (Talking Books). This material was originally recorded at normal recording speed (175 wpm) and then compressed to a variety of speeds ranging from normal to 475 wpm on the tempo-regulator. While this material has served our purposes well in the determination of the feasibility of measuring and improving comprehension of compressed speech; it remains to determine whether our findings will generalize to different, but equally appropriate material of a college level difficulty. For this purpose two disciplines other than history were selected: psychology, described below, and physical geology to be completed at a later date. These two areas of study were chosen because they represent subject matter which makes use of more technical terms but which does not usually rely heavily on the use of mathematics or visual displays in teaching at the undergraduate level and can fairly be treated as connected discourse. While compressed speech may be mixed with other teaching methods for the purposes of our experimentation we chose to treat connected discourse alone. The experiment described below concerns the development of listening material in psychology.

Procedures

Subjects. Fifty male subjects from a local university were employed as subjects for the standardization of the tests on the psychological passages. Of these one failed to complete the experiment and his results were dropped from the analysis. Of the remaining 49 subjects, twenty-two were freshmen, twenty-five were sophomores, and two were juniors. They ranged in age from 18 to 23, with a mean age of 19. Two-thirds of the subjects were born on the east coast.

Their major areas of study were as follows: 20% arts and sciences, 24% pre-law, 14% foreign service, 14% education, 6% pre-medicine, and 6% business. The remaining students were undecided. The average grade received for the last complete semester (high school grade for the freshmen, college grade for the others) was, approximately a B.

Seventy-six per cent of the subjects had had no training in rapid reading. All subjects reported having no hearing difficulties and believed their hearing to be approximately the same in both ears.

Subjects were paid approximately $1.50 per hour. Subjects were informed that bonuses based on performance would be paid to the seven best subjects: the best student to receive a $15 bonus; the second best, a $10 bonus; and the remainder, $5 bonuses.

Nearly all subjects expressed willingness to participate in a compressed speech experiment (those who did not, did in fact participate at a later date). None of the subjects had read or looked through the book used in this experiment; and only one subject had ever taken a psychology course previously. Thirty-five per cent of the subjects were enrolled in a basic psychology course but classes had been in session less than two weeks at the beginning of this experiment.

Materials. The listening material presented consisted of the first eleven chapters of a psychology textbook - Psychology, The Science of Mental Life by George A. Miller.[1] This is an introductory textbook typical of the kind assigned in a basic experimental psychology course. Editing prior to recording was kept to a minimum and was aimed at making equivalent the length and difficulty of the chapters. Having been written by a single author the material characteristics were fairly consistent throughout. Table 7 describes the passage characteristics as they were finally recorded.

Each passage was approximately 3550 words long. There were approximately 165 syllables per hundred words, so that each passage contained about 5800 syllables. The mean number of sentences per passage was approximately 170 with 21.3 words per sentence. Calculations for Reading Ease (according to the Flesch formula) and Listening Grade

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[1] Miller, George A., Psychology, The Science of Mental Life, Harper & Row New York, 1962, Pp 1-172

Table 7

Characteristics of Psychology Passages as Recorded for Use in Research on Speeded Speech as an Educational Medium

	Chapter												
	1	2	3	4	5	6	7	8	9	10	11	Mean	SD
Total No. of Words	3473	3631	3600	3589	3546	3467	3561	3525	3461	3638	3633	3556.7	64.84
Mean No. Syllables per 100 Words	164.2	169.9	160.9	160.5	164.9	169.3	160.1	161.2	169.7	163.4	165.4	164.5	3.58
Mean No. of Words per Sentence	21.4	20.2	20.2	20.6	24.3	20.2	21.2	19.7	22.0	23.2	21.2	21.3	1.19
Mean No. of Words per Indep. Clause	17.7	17.1	17.8	17.0	18.9	17.3	19.0	17.4	18.7	19.0	18.6	18.0	1.49
Total Time for Recording at Normal Speed in Minutes	21.28	22.33	21.12	22.95	22.50	21.22	21.13	21.70	21.87	23.72	23.08	22.08	.90
Mean No.of Syllables per Minute on Normal Speed Recording	268.00	276.31	274.34	251.02	259.96	276.63	269.76	261.89	268.50	250.59	260.36	265.21	8.94
Mean Deviation From 262 Syllables per Minute	6.00	14.31	12.34	-10.08	-2.04	14.63	7.76	-.11	6.50	-11.41	-1.64	3.30	8.68

according to Rogers formula, were not performed because of the essential inapplicability of such measures to college level technical material.

A comparison of the passages taken from the psychology book with those passages previously used from the textbook on English history shows the following differences: Passages are approximately 3700 words long. There are approximately 144 syllables per hundred words so that each passage contains 5300 syllables. There are about 19 words per sentence.

Probably the most crucial difference between the two types of material used is the syllable to word ratio which is greater for the psychological material. This means, in essence, that there is a greater proportion of multi-syllable words used in the passage.

The psychology passages were recorded on magnetic tape at normal recording speed. To make the speed of presentation comparable to previous material the standard employed was designated in syllables per minute, rather than words per minute. The reason for this is as follows: The time taken to produce a given speech sound is fairly constant over individuals. Variation in rate of speech is largely due to differences in duration between words. (Goldman-Eisler, 1956) However that only holds true if different speakers speak the same words. If words of different syllable length are employed, (two-syllable words vs.one-syllable words, e.g.) the duration will be directly related to the number of syllables spoken, a more natural unit of speech. Thus in keeping constant the rate of speech production so that the psychology material will be comparable to the historical material, it was decided to match them on the basis of rate of syllable production. Both sets of materials have been recorded at a rate of approximately 262 syllables per minute. Since the ratio of syllables to words differs in the two types of material, the rate of words per minute is different. The fact that the syllable to word ratio differs is a natural consequence of different vocabularies employed in the two disciplines. That difference is one which is relevant to a comparison of the feasibility of using the material for compression.

For each of the recorded passages tests were constructed which contained 40 to 45 five-option multiple choice questions.[1] These questions were of the factual, interpretative, and evaluative type. The test booklets were put on stencil and reproduced in the same form used in previous standardization measures, except that in this case a separate answer sheet was provided.

In addition to the above materials, biographical data sheets, pay vouchers, and a list of debriefing questions at the conclusion of the experiment, were presented to all the subjects for completion. Pencils were provided.

The equipment used consisted of a Magnecord tape recorder, amplifier, and speaker with ancillary wiring. The tapes were presented free field in a large classroom with good acoustics.

Design. The subjects were tested as a single group one evening and the next morning. In the first session, after completion of the biographical questionnaires and the pay vouchers subjects were told that they would be presented with tape-recorded material taken from a psychology textbook to which they were to listen closely, and that tests on each passage would be administered at its conclusion. Subjects were informed of the bonuses to be awarded, and the duration of the experiment.

The first session consisted of five passages each followed by a test. The second session consisted of the remaining six passages and tests. The material was presented in the smae order in which it appeared in the book. Breaks were provided in the middle of each session.

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[1] Some of these questions were adpated from those printed in the Instructor's Manual to Accompany Psychology, The Science of Mental Life by George A. Miller. Prepared by George A. Miller and Cynthia Norris, Harper and Row, New York, 1964

Data Analysis

Responses were key-punched and used in a score test routine which was run on a modified Harvard Graduate School of Education "Multivariate Statistical Analyzer". Each subject item was scored right or wrong. For each item, the item difficulty and the biserial correlation of the item with the subtest total score was calculated. Tallies of option choices for each item were provided. Subtest mean, standard deviations, and Kuder-Richardson reliability coefficients were calculated. After the item selection was completed for the final battery, the above was rerun for the selected items.

The following criteria were used in standardizing the tests: Items with a biserial r of less than .15 were discarded. Items which were answered correctly by more than 95% of the subjects or less than 15% were discarded. A 60% mean level of difficulty was the goal. Additional items were then discarded with that in mind until the eleven passages had similar median frequency distributions of item difficulties. In achieving this result each test was left with twenty-eight of the original forty to forty-five items. The biserial r's and Kuder-Richardson reliability coefficients were then recomputed. (See Table 8 and Appendixes B1 and B2 for data).

The newly constituted tests were then typed on stencil and reproduced for use.

Summary

Eleven passages of a length similar to previously used historical material were selected and recorded from an introductory textbook on psychology. These passages were presented at normal speed to a group of 49 college students in two sessions. For each of the passages 40-45 item multiple choice tests had been constructed and were administered at the conclusion of each playback. Biserial r's, and item difficulty were computed along with overall test reliabilities. The tests were reduced to 28 items each with similar difficulty and reliability characteristics, and characteristics which were similar to the previously used material. This test standardization was done for the purpose of using the new material in a later experiment to compare psychological with historical material with respect to their feasibility for use in compressed speech presentations.

Table 8

Characteristics of Tests as Standardized on a College Population

	Chapter										
	1	2	3	4	5	6	7	8	9	10	11
Mean Number of Items Correct out of 28	17.4	17.5	16.6	15.8	17.4	14.9	16.8	16.1	17.2	15.6	17.0
SD	4.8	4.7	4.5	4.4	4.6	4.8	4.2	4.4	5.0	4.7	4.0
Kuder-Richardson Reliability	.78	.79	.75	.74	.77	.76	.72	.77	.81	.76	.74

The Use of Compressed Speech as a Review Technique

Introduction

Previous research conducted under this grant has established the feasibility of improving the comprehension of compressed speech with practice. The material used has been college level textbook chapters and the subject population fairly representative college students. It is natural now to explore the ways this may best be used for educational purposes. One major potential use is as a supplement to the college lecturer in the presentation of new material. Our laboratory research to date has suggested that this use is entirely feasible.

Another way in which compression may prove of value in this setting is as a technique whereby the student may review familiar material. There are some inherent advantages in repeated oral presentation as opposed to visual display; chiefly the preservation of intonational patterns, emphases, meaningful pauses, etc. The preservation of those characteristics combined with rapid presentation could be beneficial in a review situation. Thus the need for an experiment testing the efficiency of compressed speech as a review technique was indicated. The following experiment investigates the use of speech compression to present familiar material, to untrained listeners.

Rationale

One of the major findings of previous research conducted under this grant is that exposure to compressed speech improves performance on new material presented at that speed. The degree of improvement resulting from practice is considerably greater when the same material is presented again (see Progress Report #2, January 1966). In one experiment mean score rose from 60% of normal score on the first administration of a passage at 375 wpm to 98% on the second one, when it was administered immediately afterward. For these reasons it was felt that the presentation of the same passage after a considerable interval of time might provide an adequate review. This was examined with a group of untrained listeners. The group was split into two matched halves, one of which reviewed by compressed speech the other by reading.

Procedures

Subjects. The subjects used in this study were drawn from the population on which the Miller psychology book tests were standardized. Of the forty-nine students who participated in that experiment, twenty-two subjects agreed to return. Of these, half were freshmen and half sophomores, with an age range from 18 to 20.5, mean age 19.0. Their general characteristics were similar to the larger group from which they were drawn, described earlier, except that their average grade for the previous semester was approximately B plus, the larger group having averaged a B. Hearing was considered normal by the subjects, about a quarter had had rapid reading training, none had experienced rapid or compressed speech.

Subjects were paid approximately $1.50 per hour. They were told that they would be divided into two groups, one member of each group to receive a ten dollar bonus based on performance.

Materials. The listening material in this experiment consisted of the first four chapters of the psychology text previously presented in the Standardization Study. These tapes were compressed on the tempo-regulator to speeds of approximately 524 syllables per minute from a normal recording speed of approximately 262 syllables per minute. The subjects listened to no other material. One group heard these tapes. The other group was presented with typewritten copies of the text of each of the four passages. All subjects received the same tests. The tests used were the revised versions of the tests used in the Standardization Study. These tests each had twenty-eight five-option multiple choice items. An answer sheet was used along with them. At the end of the experiment the listening group was presented with two debriefing questions concerning possible changes in their listening comprehension and their preferences for mode of review.

The equipment used consisted of a Magnecord tape recorder, and amplifier and speaker with ancillary wiring. Pencils were supplied to the subjects.

Design. The main purpose of this study was to examine the use of compressed speech as a reviewing technique with naive subjects, and compare it with the conventional method of reviewing (reading). For this purpose the returning subjects, all of whom had been exposed to the material at normal speed seven weeks before, were divided into two matched groups based on their original scores on the four passages. The subjects were given a brief introduction explaining that they would be divided into two groups, one of which would read the material they had heard last time, while the other group would listen to it at high speed in another room. All were informed that they would be tested on this material immediately following review. Subjects in the reading group were encouraged to review from the printed passage in whatever way they chose for the same duration of time as the tapes were played to the other group. The listening group was not allowed to take notes.

The four passages were presented in the following way: The first and third passages were presented twice in succession; the second and fourth were presented once each. Passages one and three were presented twice, in order to provide practice for these untrained listeners. Thus the experimental design afforded two comparisons: between the reading and listening groups, and between single and double durations of exposure.

Findings. Mean scores for the two groups are presented in Table 9.

The reading group was significantly better than the listening group overall as determined by a two-factor analysis of variance $F = 16.5745$ (df, 1,20; $p < .01$.) The interaction between groups and different tests was statistically significant: F (3,60)= 3.5645 (df, 3,60; $p < .05$.)

Examining performance on the double presentation separately from the single presentation of passages, the following conclusions may be drawn. Performance on the second double presentation for the listening group showed no change, that for the reading group showed a significant decline ($t = 2.35$, $p < .025$). There were no differences between the scores on first and second single presentations.

Table 9

Mean Scores on Passage Tests by Group

Tests in Order of Presentation

	Unrevised Tests Normal Speed	Revised Tests, 375 wpm*			
Passage	1-4	1	2	3	4
Listening Group	19.8	11.2	10.7	13.0	12.1
Reading Group	20.7	21.2	17.1	18.4	17.3

*Listening group heard passages presented at 375 wpm while reading group read passages for same length of time.

Differences between double presentation (in the case of the reading group this really means twice as much time available to review) and single presentation were not significant for the listening group, but the reading group performed significantly better with twice the time to review ($\underline{t} = 3.40$, $\underline{p} < .005$).

Discussion. Familiarity with the material was not sufficient to overcome the handicap of lack of training in compressed speech comprehension. In this experiment it appeared that reading was a superior review technique. It should be noted that although the subjects had heard the material once, seven weeks had elapsed before its presentation again as compressed speech, and unlike a typical college course, during that period the subjects had no exposure to related material. The fact that the listening group benefited less from double presentation that the reading group (which had twice the time) may be a result of a lack of comprehension of the speeded material on the initial presentation. It can be seen that on the second double presentation (third passage) listening group results were better than for single presentations. This suggests that with more training double presentation may prove of greater value.

Seven of the eleven subjects in the listening group reported that their listening comprehension had improved during the course of the experiment. Although seven of the eleven said that they preferred reading for review within a limited time space, the remaining four all said that they would prefer compressed (not normal speed!) speech as a review medium.

Listening Aid Study II Extension

Background:

This experiment was designed to provide information on two questions: Can a trained subject retain his ability to comprehend compressed speech? And, to what extent is compressed speech useful as a method of reviewing familiar material, relative to reviewing by reading?

The problem of retention of skill is potentially important if compressed speech is to be used at regular, but widely separated intervals, in the educational setting. Previous experimentation (e.g. Listening Aid Studies I and II) have demonstrated that with five or six hours of practice listening, comprehension approaching normal can be achieved at a rate of 375 wpm or more than double that at which the material was originally recorded (175 wpm). However it remains to be seen whether that listening ability can be maintained or more rapidly relearned. Previous research conducted under this grant has indicated that while the content of what has been learned via compressed speech is retained as well as that learned at a normal rate, the skill quickly disappears. (See Progress Report No.2, January, 1966).

In the first retention study experimental and control subjects who had been tested in the spring, were called back six months later. While both groups showed significant loss in retention of the content over that length of time they did not differ significantly from each other. In that experiment subjects were also given a new passage at 425 wpm to measure retention of skill. Experimental subjects declined 22% and control subjects 12%, amounts which were significantly different from the test scores at that speed at the end of the original experiment.

In a second experiment, subjects who had been exposed to normal speed passages for purposes of test standardization, and one 425 wpm passage (without prior training) were called back one month later. They were retested on the normal speed tests (without passages) and were given a new passage at 425 wpm. The losses in content at normal speed were about 40% (60% of original scores were achieved). At 425 wpm on the new passage there was a drop in comprehension of about 9%, however the scores were so low to begin with that the drop is not too meaningful. An additional new passage was presented at 325 wpm but owing to artifactual noise, produced no interpretable data.

A third experiment was run in which trained listeners were recalled one month after training. All the tests they had on passages presented at speeds ranging from 175 to 475 wpm were readministered (without passage presentation). On the 425 and 475 tests no loss of content appeared. On the remaining passages (175-375 wpm) about 70% of the content was retained. On the new 425 wpm passage mean scores dropped 14%, however they were at a level which was not different from naive subjects tested at that speed (in the previous retention study) so that one cannot say skill was retained. On the new passage at 325 wpm a drop of 11% occurred, however again, their mean scores were not much better than a naive group at that speed so again little evidence of retention of listening skill is apparent.

Thus prior evidence suggests that while retention of content of material presented at high speed in general compares favorably with material presented at normal speed, retention of skill is not usual.

In the experiment described below, an attempt was made to examine the retention of skill and the usefulness of compressed speech for review purposes by a group of trained listeners. These listeners are those who were trained in the second Listening Aid Study described earlier in this report.

Procedures:

Subjects. The subjects were twenty volunteers, all participants in the second Listening Aid Study. All were trained listeners, who had received 6 hours of rapid listening practice (375 wpm) during the Listening Aid Study. All subjects in the Listening Aid Study were asked to return; the characteristics of the subjects who returned did not differ significantly from those of the entire group, (see Listening Aid Study subjects); the subjects returning were those who were available on the afternoon chosen for this study.

Materials. The listening materials used in this study consisted of the same four tape recorded psychology passages used in the Review Study with naive listeners. These passages were compressed to a rate of approximately 524 syllables per minute. Two of these passages were the psychology passages played at normal speed for these subjects during the Listening Aid II Study (passages M-1 and M-2); typewritten copies of those two passages were also used.

The equipment consisted of a Magnecord tape recorder, Bogen amplifier, Electro-Voice speaker and ancillary wiring.

Method. The experiment took place 3 weeks after the last day of the Listening Aid Study. It will be recalled that at the outset of the Listening Aid Study, all subjects listened to two passages of psychological material, at normal speed (262 syllables per minute); immediately following each of those passages, subjects had been given an appropriate comprehension test for that passage, the unstandardized version. Subjects were given two scores on those tests: a) A score on the total test including those items which were subsequently discarded for purposes of standardization b) a score on only those items which comprised the standardized version of that test.

Subjects were divided into two groups for this experiment, on the basis of their mean total scores on the two psychology passages given in the Listening Aid Study. One group was designated the "reading group" and the other the "listening group".

A total of four passages were presented to the subjects The first two were presented to test the retention of the skill of high speed listening. All subjects were given the same treatment. On the last two passages, subjects in the reading group read the passages, while subjects in the other, the listening group listened to the passages.

The first two passages to be presented were the 3rd and 4th chapters from the same psychology book as those psychology passages administered in the Listening Aid Study. They were presented at 524 syllables per minute. After each of these two chapters, the standardized test for that chapter was given.

A ten minute break was then given, following which the two groups were placed in separate laboratories. The two psychology passages administered then were the same passages administered at the outset of the Listening Aid Study. After each passage, the standardized test for that chapter was administered. In one laboratory, the reading group read each of these two chapters. They were supplied with pencils and allowed to review the material as they wished. The amount of time allowed for review was the same as that given to the listening group for listening. The listening group listened to both passages at 524 syllables per minute. The first passage (M-1) was played twice. The second passage (M-2) was played once. The listening group was not allowed to take notes while they listened. They were given the same tests as the reading group a[illegible]ach passage.

Findings.

In order to compare results on the first two passages presented to measure retention of skill (M-3 and M-4), with earlier performance, scores on these tests were compared with scores on the normal speed original presentations of M-1 and M-2 after those test scores had been recalculated after standardization had eliminated items. Thus scores on tests of equal length and approximately equal difficulty were compared. This unconventional look at the data is solely for purposes of tentative hypothesis development and must not be considered a legitimate statistical technique for data analysis. The per cent of normal speed performance was obtained by dividing the M-3 and M-4 scores into the mean normal speed scores. (See Table 10) In the same way, scores on the M-1 and M-2 passages in this study were divided by scores on the standardized versions of those tests.

On this basis the listening group performed at 73.5 and 77.2 per cent of normal scores on new material, while the reading group had scores of 88.8% and 98.3%. These tests were presented three weeks after the earlier experiment had been concluded. When the scores are compared with results on the final test presented in that study (passage C-4 presented without any listening aids) at approximately the same speed, there is no decline in performance for either the listening or reading group. Scores on that test were 68.4 and 90.1 for the two groups respectively. The data also

Table 10

Mean Scores and Per Cent of Normal Speed Scores of Trained Listeners on New and Familiar Material Presented at Two Times Normal Speed

	Listening Aid Study Extension			
	New Material		Familiar Material	
	M-3[a]	M-4[a]	M-1[b]	M-2[c]
Listening Group (N=10)				
Scores, Corrected for Guessing	9.52	9.70	13.18	9.65
Percentages of Normal Speed Score	73.52	77.22	103.41	82.91
Reading Group (N=10)				
Scores, Corrected for Guessing	11.12	10.88	16.90	13.22
Percentages of Normal Speed Scores	88.83	98.32	143.60	123.14

[a] Per cent of M-1 and M-2 at normal speed, standardized items only.

[b] Per cent of M-1 at normal speed, standardized items only.

[c] Per cent of M-2 at normal speed, standardized items only.

suggests that performance improved when the second passage (M-4) was presented in this study.

When passages M-1 and M-2 were presented to the current group the listening group (which heard M-1 twice, and M-2 once) performed at 103% of normal score on M-1, and 83% on M-2, while the reading group (which was given equivalent time to review by reading) performed at 144% on M-1 and 123% on M-2. The double time condition added approximately 20 percentage points to each group's score. The reading group on this measure of reviewing performance was superior to the listening group.

Discussion:

This experiment, while providing some interesting results, must be considered as no more than a first cut at an examination of the ability of trained subjects to review by means of compressed speech. There are a number of problems in interpreting this data which were anticipated, but it was felt that with little additional expenditure of time and money this adjunct to the second Listening Aid Study was worth doing. Retention of skill was measured against performance on earlier tests in the same subject matter but those tests had been presented prior to standardization. It was also compared with different subject matter at high speed (Passage C-4) presented at the end of the Listening Aid Study. An examination of those scores shows that the reading group in the study was superior on that material, although the two groups were equivalent on the same subject matter presented at normal speed.

With the above reservations, it may be noted that performance on new material after a three week lapse, wasn't bad, the second test presented showed some improvement. Double exposure at high speed to familiar material provided scores better than the original. Single exposure showed some loss for the listening group, a better performance for the reading group. Since the tests were re-presented as well as the passages, however, a condition in which new tests are used with the same material might provide a more telling result. It should also be noted, that while the subjects of this experiment were trained in listening to compressed speech, they had no training in using it as a reviewing technique. It is possible that the novelty of that situation may detract somewhat from the potential benefits that might accrue from reviewing with compressed speech by trained listeners. We feel that further investigation of this possibility is called for.

Overall Summary

This project report describes the most recent research in a series of experiments begun under a grant from the New Educational Media Branch of the United States Office of Education in 1963, and continued through a second grant awarded in 1965. The research reported here covers a wide gamut of topics; the use of a precis as a listening aid to comprehension of compressed speech, the use of pure tone as an aid in signifying important parts of a passage, the efficacy of compressed speech to be paced by the listener, the ability of trained subjects to retain the listening skill they have acquired after a three week lapse, and the potentialities of compressed speech as a review technique for naive and for trained listeners.

Two of the major findings of previous research were reaffirmed: Exposure to compressed speech will improve comprehension of new compressed material; in general subjects find material presented at more than double normal recorded speed an acceptable way to listen. The listening aids employed in the study in this report were no more helpful than those used in an earlier study. While all groups of subjects improved over time, there was no difference between groups without aids, and those with, in terms of overall comprehension. An examination of self-pacing behavior showed no difference from performance under externally-paced conditions, both with regard to the chosen rate of presentation and ability to comprehend the material. However this was a new technique for the listeners and it is felt that the more extensive use of this technique in an experiment might provide richer results. The experiments reported here on the feasibility of using compressed speech as a review technique show that both for naive and trained listeners reading for the same amount of time provided superior results. However, the gap between reading and listening groups was greater for the untrained than for the trained listeners. The latter group was not tested under ideal conditions, however it was decided to take a first cut at the problem. The results are such that a more intensive study of reviewing by trained listeners is desirable. The retention of skill by this group shows some promise that skills do not fade rapidly, and that rapid improvement in performance can be effected with some additional exposure.

One major question remains to be examined under this grant: The feasibility of compressing different types of material for presentation to college students. The groundwork has been laid for a comparison of the comprehension of college level material in the fields of history, psychology, and physical geology, which will be described in the next report.

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APPENDIX A

C-7

The Inns of Court and the Lawyers

Precis

The author is most concerned with the type of lawyer called to the bar and practicing before the King. This particular lawyer might have had any one of several backgrounds.

The training for law took place in "The Third University of England." The establishment of the Inns of Court as an institution in England occurred several centuries ago. Special names were given to the students of law depending on the number of years they had been at the Inns of Court. The author also defines the term "ordinaries."

There was no formal examination at the Inns of Court but the author does mention a situation in which the excellence of legal training is proved. As part of university life, lectures were given by certain lawyers, and on occasion students presented the plays of a favorite playwright.

Certain English institutions evoked the sympathies of the students -- others their criticism. This criticism illustrates the students' prevalent interest. It also influenced the attitude of the King toward lawyers.

The author tells us what proportion of the students left the Inns of Court and returned to their homes to find other jobs. Those who did finish had to establish practices. The author mentions several ways that a lawyer could go about this, as well as the requirements for being admitted to the bar.

One classification of lawyers was discussed briefly since little was known about it, but it was known that most of their clients were landed gentry.

In one of the English counties, dynasties of lawyers can be traced. The author's final statement sums up his impressions of legal training.

Selection C-7

The Inns of Court and the Lawyers

Directions: Read each question carefully and choose the best answer. On the line at the left of the question number place the letter corresponding to the answer you chose. Work quickly but accurately. You may answer a question even if you are not entirely sure of the answer, but do not guess wildly, since you will be penalized for wrong answers.

_____1. Of the following groups, least is known concerning

a. Readers.
b. London lawyers.
c. judges.
d. Utter Barristers.
e. country lawyers

_____2. "The third university of England" was comprised of

a. Lincoln's Inn and Gray's Inn.
b. Inner Temple and Middle Temple.
c. the Inns of Chancery.
d. the Inns of Court.
e. the Inns of Court and the Inns of Chancery.

_____3. At the Inns of Court, lectures were given primarily by

a. Judges.
b. Readers.
c. Serjeants-at-Law.
d. Mootmen.
e. Inner Barristers.

_____4. The Inns of Court were already an established institution by the

a. fourteenth century.
b. fifteenth century.
c. sixteenth century.
d. seventeenth century.
e. eighteenth century.

_____5. Of the following, the barrister was least likely to have a father who was a

a. member of the landed gentry.
b. barrister.
c. solicitor.
d. merchant.
e. physician.

_____6. A county known for its dynasties of lawyers was

a. Devonshire.
b. Hampshire.
c. Gloucestershire.
d. Warwickshire.
e. Shropshire.

_____7. During their first two years at the Inns of Court, students were referred to as

a. undergraduates.
b. Readers
c. candidates of law.
d. apprentice attorneys.
e. Clerks Commoners

_____8. One aspect of the lawyers's life not described in detail by the author is his

a. background and origins.
b. courtroom manner.
c. school training.
d. obtaining a practice.
e. clientele.

_____9. A playwright who was a special favorite of the lawyers was

a. Johnson.
b. Shakespeare.
c. Moliere.
d. Bacon.
e. Goethe.

_____10. Admission to the bar was based on

- a. an oral examination.
- b. completing a fixed number of courses.
- c. serving a specified apprenticeship.
- d. a general estimate of qualifications.
- e. payment of a fixed fee after the required years of study.

_____11. Among the means of increasing legal practice, the author indicates that lawyers used all of the following except

- a. taking part in a "cause célèbre".
- b. publicity within the legal profession.
- c. making famous arguments in Parliament.
- d. working for more successful lawyers.
- e. offering the use of a large memory.

_____12. According to the author, the training received by a lawyer led to

- a. a superficial and unintellectual view of life.
- b. intellectual honesty and honesty of conduct.
- c. an overemphasis on material gains and comfort.
- d. unscrupulousness and dishonesty in business dealings.
- e. loyalty to clients and self-sacrifice.

_____13. Those who could practice before the King's courts were called

- a. attorneys.
- b. professors of law.
- c. Readers.
- d. barristers.
- e. benchers.

_____14. Which of the following were called to the bar?

- a. Solicitors
- b. Barristers
- c. Attorneys
- d. Justices of the peace
- e. All of the above.

_____15. Students of law who did not become barristers entered other professions. One such profession not mentioned is

a. Member of Parliament.
b. justice of the peace.
c. undersheriff.
d. deputy lieutenant.
e. Serjeant-at-Law.

_____16. The number of Inns of Court was

a. two
b. three.
c. four.
d. five.
e. ten.

_____17. The major part of the author's comments is given to a description of the lawyer's

a. training.
b. professional life.
c. courtroom behavior.
d. achievements.
e. social morés.

_____18. The majority of students at the Inns of Court

a. eventually became barristers.
b. became members of Parliament.
c. left before passing the bar.
d. also studied abroad.
e. eventually became judges.

_____19. The sympathies of lawyers were likely to be with all of the following except

a. Puritanism.
b. Parliament.
c. the monarch.
d. common law.
e. the judges.

____20. The term "ordinaries" referred to

a. living quarters for students outside an Inn of Court.
b. trials pleaded without benefit of a lawyer.
c. students enrolled for only two years at the Inns of Court.
d. clients who did not own any land.
e. briefs prepared by lawyers in civil cases.

_____21. Criticism of James I by students is cited by the author as evidence for

a. the existence of academic freedom.
b. lack of refinement among students.
c. general low esteem of this monarch.
d. insurrection among law school faculties.
e. student interest in politics.

_____22. Prior to becoming Utter Barristers, the lawyers in training were known as

a. Readers.
b. Bailiffs.
c. Mootmen.
d. Clerks Commoners.
e. pleaders.

_____23. The attitude of the monarch toward lawyers of the time is best described as

a. antagonistic.
b. friendly.
c. anxious.
d. materially benevolent.
e. interfering.

_____24. The author cites the debates in the House of Commons as evidence of

a. the quality of legal training.
b. the decline of legislative honesty.
c. loopholes existing in the law.
d. the power of the Law.
e. the need for more legal training.

_____25. Clients for lawyers practicing outside London came primarily from

a. landed families.
b. landed and commercial families.
c. yeomen and tradesmen.
d. nobility.
e. a fair cross section of the population.

In 30 seconds Selection C-7 begins...

The Inns of Court and the Lawyers

From late colonial days to the present the lawyer has played a leading role in the life of the United States. He had no less a role in the England of the days before the colonists crossed the Atlantic. He had many functions, but above all he was the right-hand man of the country gentleman, preserving the titles of his land for him. His value was recognized: presents of venison arrived at his office in Chancery Lane; and when he came to the country, he was treated with due observance.

Among lawyers the barrister is the one with whom we are most concerned. He was one who after long residence in one of the Inns of Court had been called to the bar, and he alone could practice before the King's courts. But there were also attorneys and solicitors who prepared cases for barristers and who practiced before minor courts.

The barristers were, many of them, younger sons of the gentry and occasionally eldest sons. They were also sons of barristers, of attorneys and solicitors, merchants, and well-to-do businessmen, and occasionally the sons of clergymen or physicians. There were instances where even a yeoman's son was able to afford the expense of the long training at the Inns and to qualify for the bar.

The training was at one of the four Inns of Court; Lincoln's Inn, the Inner Temple, the Middle Temple, and Gray's Inn. Those Inns together with the Inns of Chancery made up something like a university. It was "The third university of England" and by the sixteenth century was already an established and characteristic English institution. It served the profession of law, but it was thought of also as a training ground for the sons of the nobility and the gentry and for those entering the service of the commonwealth. When the American colonists in the eighteenth century wished to give their sons advantages, they sent them to one of the Inns of Court.

For all their importance the Inns were not corporate bodies. They developed no set laws but ruled by custom. They were not connected in any way with the state, and yet they had complete control over the education of the men who carried on the law. Each of the Inns had a governing body. That body was self-perpetuating, and consisted of established men in the law, who decided questions of allotment of rooms, instruction, the conduct of members, promotions in rank, and, above all, finance.

The students were supposed to live within the Inn, two in a chamber. Not all of them could be accommodated within the quadrangles; some lived at "ordinaries" outside, and awaited their turn to find rooms, or stayed outside for more freedom. Every student was supposed to partake of Commons or meals for a certain fraction of the year--from eight weeks to three months. Dinners were at noon and supper at six or seven o'clock. In hall the students were not allowed to wear hats, though caps were permitted, nor were they to appear booted or spurred or carrying swords.

A student coming to London for legal training might enroll for two years at one of the Inns of Chancery, and then go home to be a justice of the peace. Or he might proceed straight to one of the four Inns of Court. By the seventeenth century many men were going directly to the Inns of Court. If they did so, they had, during the first two years, few fixed exercises, but were supposed to do much reading and talking of law; they were called Clerks Commoners. After two years they became Mootmen or Inner Barristers. In five or six more years if they were fortunate enough to be called to the bar at the end of that time, they became Utter Barristers. The Inns were sometimes limited in the number of Utter Barristers they could name in a single year, and did not by any means choose all who had spent the required period. There was no formal examination, and there was not always a fixed number of exercises to be completed. The education was rather a flexible one, and the admission to the bar must have been based upon a general estimate of a man's qualifications.

An Utter Barrister had not completed his training. For at least three more years and sometimes for four or five, he had to perform exercises and to assist in directing the studies of the younger men. In theory he could not plead before the general courts at Westminster until those years had elapsed, though in reality he sometimes did. In most instances he carried on law work in the offices of other men and probably prepared cases for them.

The details of the schemes of education differed much from Inn to Inn. There were moots, bolts, imparlances, putting cases, and readings. The moots were most important. Students were given topics in advance on which to prepare a pleading. Two men, sometimes one of them younger and one further along, were assigned to argue an issue. Their arguments were then criticized by older men, by Readers and Benchers, perhaps by a Serjeant-at-Law, or by a great judge who happened to be in residence. In some moots men had to plead extemporaneously; in others the student was required to recite the pleading from memory; in still others the pleadings were given in law French, which the student had to turn at once into English. Putting a case was a less formal procedure. As men were at dinner or supper one of the older men might put a case and question all those at the table as to what action should be taken and what pleading used.

Young men walking about the quadrangles were encouraged to put cases to one another, and those who were skillful became known as put-case men. Law, said one Serjeant-at-Law was a babblative art; men should study all morning and talk all afternoon. Freedom to walk about and discuss the law was considered so important that a plan for a new building in one of the Inns was opposed because it would cut down the walking space and so interfere with put-case men.

The most formal element in the education was the lectures given by the Readers. A Reader would be allowed half a year in which to prepare his lectures and then would give them over a period of weeks or days. The lectures would be devoted to the exposition of a statute, or more often to a series of statutes, explaining why the statutes had been passed, at what abuse they were aimed, and how they differed from earlier legislation. Before he was done the Reader would point out vague phrases in the statutes and indicate the ways in which those phrases might be interpreted.

It was a long training and men who had gone through it with attention and purpose must have been as thoroughly trained as anyone in England. Law schools, said the historian Maitland, make tough law. One can see the effects as one scans the reports of the great judges. The debates in the House of Commons, where many members were old Inns-of-Court men, prove how good the training was. There were men who could gather together the arguments made in the House over a period of several weeks, point out the holes in each argument, and then go straight to the root of the matter. They knew exactly how to phrase a proposed bill so that it was perfectly clear.

It was the hope of wise old lawyers that the training in the Inns made not only for precision but for breadth of view. They urged the students to study history, and English history in particular, and to make themselves familiar with languages. Some of the best lawyers and judges were men of broad scope. They had the wisdom that comes with experience of human behavior, and that accumulates when good minds apply themselves to what other good minds have set down in print.

Unfortunately the training was less rigorous in the early seventeenth century than it had been earlier, or so observers thought. It was noticed that attendance at the various exercises was becoming less regular. Young men found that by paying fines they could avoid the preparation of moots, and they were not always discouraged by those in authority who liked to see the funds of the Inn increase. It was said further that Utter Barristers and Readers were neglecting their duties. In this charge there was probably truth. From the last half of Elizabeth's reign there had been an enormous increase in the numbers of students, and especially of those who came to enjoy themselves. Where students intent on matters other than their studies flock in, standards deteriorate, and even teachers lose interest. Moreover, any formalized system of education tends to lose its initial impulse.

The Inns had much to offer besides moots. They were like clubs, which men joined because their fathers had belonged. A young man not only met youths of his own kind but was thrown easily and naturally into contact with great lawyers and judges, and sometimes with national figures. Whether he learned law or not, and he could hardly escape absorbing a little, he caught the tempo of his time and breathed the air of a great center.

He might frequent Paul's Walk and hear gossip of the court and of Parliament and of what was happening in Germany. In his own Inn he was likely to hear about politics. In an unpublished diary of a student in Gray's Inn is evidence that the students talked public affairs and were critical of James I. If the young man listened to older men in the Inns, he would have heard much against royalty. James was said to have told the lawyers that he would quit the hunting of hares and hunt them. The lawyers resented his statements about them, his attacks on the law, and his bullying of the judges. Many of them favored Parliament as against the King, and were likely also to have puritan sympathies. Not all the young men would have agreed with such lawyers, but we may be sure they would have discussed the questions. They were studying the common law, and it was under fire.

The students had more frivolous interests. They thought the Christmas season, which lasted twelve days, demanded gaiety. Some of the gaiety was frowned on as unseemly, but a certain amount of decorous festivity was often provided for. At dinner the great meat dish would be brought in with state and music and much bowing. Then would come the singing of hymns and carols, and the Master of Revels would sing and call on others to join him. Dancing might follow and a Lord Chancellor might lead off with a few steps. All this was fun for the young men, and so were the celebrations when a Reader was appointed or a Reader became a Serjeant-at-Law. There would be a procession and perhaps a feast. Not infrequently the students were allowed a play. Shakespeare's _Twelfth Night_ and the _Comedy of Errors_ were special favorites and were frequently played in the various Inns.

The students flocked to the theaters. At the foot of the Temples one could take a boat across to the playhouses on the Southwark side. That Inns-of-Court men and playwrights and actors consorted together has been abundantly proved. Shakespeare's plays are full of allusions to the law and to the men who studied law. It will be remembered that Falstaff had been to Clement's Inn (an Inn of Chancery) and there are references to others.

Most of the Inns of Court men never became barristers. After a year or two they went home to become justices of the peace, undersheriffs, deputy lieutenants, and possibly members of Parliament. But the Inns had left a stamp upon them.

The best men usually took up practice. How did they set out to gain a practice? They might continue at the Inn, moving up from Utter Barrister to Reader. A successful Reader might hope to become a Serjeant-at-Law, and so be on his way to a judgeship. The ladder of promotion for those who had made a brilliant record at one of the Inns was a short one-piece ladder. They might attract the attention of one of the great judges and be invited to follow his circuit, that is, to accept cases before him as he went from the assizes of one county to those of another. Such men were in line for a career. Or the young lawyer might attract the attention, not of a judge, but of a great London lawyer who would turn over cases he could not accept to the young man, or who might whisper to friends, until word got around that the young man was likely to be heard from.

Of course, many of the lawyers gained their practice through family influence. A young attorney settling in Chancery Lane found it quite natural that a gentleman from his native county of Shropshire who came to London to get legal advice should visit him and retain his services. In fact, attorneys friendly to his family in several towns of that county would frequently send him their business before the King's courts at Westminster. There were, indeed, barristers who cultivated attorneys in the hope of getting business, but the best of them avoided that method of gaining clients.

Men did not, as they do today, gain a large practice by having taken part in some cause celebre. There was little publicity for barristers, except in the legal profession itself; though it is possible that lawyers who made famous arguments in Parliament thereby gained fame which benefited their practice. As the reputation of a barrister spread, country boroughs and sometimes ecclesiastical corporations asked him to take on their business and paid him an annual fee for it. Indeed, gentle families would occasionally retain a barrister at so much a year.

Some lawyers found the going slow at first. They were usually those who had been reckoned plodding students, and had only by intense application, and possibly by pressure from friends been called to the bar. They could not tender their services to anyone, but had to sit gaping in their chambers until someone chanced to knock at the door. In the meantime they might make a living by working in the offices of more successful men, or gain clerkships, or small offices with fees attached. Sooner or later some of these plodders did rather well. There was always use for men with stored memories. One lawyer was called "Index," and men went to him for information rather than interpretation.

About country lawyers we know less than we could wish. It is evident that some men who had been called to the bar settled in corporate towns where they saw opportunities for business. Many of the country lawyers were probably not barristers, although they may have had a year or two at one of the Inns of Court or of Chancery. Much of their law they had picked up from other attorneys under whom they had served at first, some of it no doubt from manuals, and more from experience. They did paper work of all kinds; conveyancing, drawing of deeds, making of marriage settlements and land transfers. But they appeared also before borough courts and in quarter sessions. In those sessions they defended petty criminals and no doubt taught them the many methods of legal delay. Some of them knew the art of bribing juries. As one lawyer explained, he never practiced before a judge, but confined himself to quarter sessions where he had "good gettings."

Although country lawyers and London lawyers with country clients served many classes, yeomen and tradesmen and occasionally even husbandmen, most of their work was with the landed families. In some instances the lawyer for a family was also its steward. Such a post was naturally profitable. Land was held by many kinds of tenures and leases that afforded opportunities for quarrels. Country gentlemen were often self-willed men, insistent upon what they believed were their rights and ready to go to law to maintain them. It was a quarrelsome generation and lawyers benefited. The gentlemen often paid the lawyer by giving him long leases because he did not have the cash at hand, and the lawyer knew how to make such leases grow in value. Moreover he was on the inside of family and community affairs and knew who was in straits and needed to sell quickly. He knew when and how to pick up at a bargain a good meadow or a piece of woodland.

In Warwickshire lawyers graduated rapidly into country gentlemen. Dynasties of lawyers can be traced in that county. One of them might serve half a dozen families, and his son and grandson might continue to do so, even after he had a coat of arms, or quarterings, over his front door.

It was a convention in the early seventeenth century, as in other times, to speak ill of lawyers. They were ignorant of Latin and pretended to know more than they did. They persuaded landlords to increase their rents and they made quarrels in order to compound them. They searched through the penal statutes and found good men liable for infractions of forgotten laws. They leaped over hedge and ditch, as an Elizabethan poet put it, and taught the gentleman how to undo his tenants about boundaries and rights in fields. They undid the gentleman himself and got his estates from him, and then slept in purple and warm furs. Stories often circulated about various lawyers that they had taken great advantage of the gentlemen who retained them, and would, indeed, soon have the entire estate for themselves. But the truth frequently was that the lawyer, by his long search for lost documents and by his talent as a sleuth, had won a whole parcel of manors for the gentleman and deserved even more than his employer had bestowed upon him.

The lawyers were probably not worse or better than other men of their time. They were more successful than most because they had a skill much in demand, and thus roused envy. It must not be forgotten that as students they had had ideals set forth to them by their elders. The leaders of the Inns urged young men to give counsel in good causes and to discourage those who had evil causes. They laid emphasis upon gentility as requisite for those entering the Inns because they hoped thus to enroll in the profession men of traditions honor. Their hopes may have been often disappointed, but not always. One remembers attorneys who little valued the profits of their practice and were ready to give any man counsel, especially to poor clients. One could name many lawyers of that time whose general character makes us feel certain of their professional integrity. It was not merely the advice of his elders in the profession that weighed with the young lawyer. His whole training had made for thoroughness and precision of statement and must have led to intellectual honesty and honesty of conduct.

APPENDIX B-1

Biserial r for Items of Psychological Test Standardization

r	M-1	M-2	M-3	M-4	M-5	M-6	M-7	M-8	M-9	M-10	M-11
.96-1.00											
.91- .95			2								
.86- .90					1			1	1		
.81- .85		1			1						
.76- .80		1	1		1				1		
.71- .75	1	2	1	1			1	2	1		1
.66- .70	1	3	1	1	1	1	1	5	2	2	1
.61- .65	4		2	2	3	3	2		5	5	3
.56- .60		2		5	3	2	4	1	3	2	3
.51- .55	5	7	6	3	2	4	4	3	4	1	4
.46- .50	5	2	3	3	8	2	3	5	3	4	3
.41- .45	3	4	2	4	2	7	1	4	2	3	5
.36- .40	6	2	2	2		5	2		1	8	2
.31- .35		1	3	3	3	3	4	1	2	1	
.26- .30	1	2	3	2	1		3	4	3	1	3
.21- .25	2	1	1		2			2			2
.16- .20			1	2			1			1	1
.11- .15							2				
.06- .10						1					
.01- .05											
- .00											
Median	.4800	.5267	.5100	.4767	.4975	.4459	.4767	.4900	.5475	.4600	.4267

APPENDIX B-2

Per Cent Passing for Items of
Psychological Test Standardization

	M-1	M-2	M-3	M-4	M-5	M-6	M-7	M-8	M-9	M-10	M-11
%											
96-100											
91-95		4	1	3	1		3	1	2	1	1
86-90	3	1		2	3		1	3	2	1	1
81-85	1	2	5		1	2	3	3	1	2	4
76-80	1	3	2		3	1	3	1	1	3	1
71-75	4	2	1	1	5	2	1	4	5		4
66-70	3	1		1		2		1	1	2	1
61-65	2	1	5	6	1	3	3	1	2	2	2
56-60	6	3	1	2	4	1	2	1	2	2	3
51-55	4	2	5	4	1	5	1	3	4	2	4
46-50	1	2	2	1		4	2		1	2	1
41-45					3	1	1	1		3	
36-40	1	3	2	1	4	2	2	1	4	3	1
31-35		4		2	1	2	3	1	2	2	2
26-30			1	2		1	2	3	1	2	1
21-25			1		1	1	1	1			
16-20	2		2	3		1		3		1	2
11-15											
6-10											
1-5											
Median	61.0	61.0	61.0	58.5	61.0	53.0	61.0	61.0	61.0	53.5	61.0

APPENDIX C

Raw Scores, Corrected for Chance

	Listening Aid Study - Baseline Data			Listening Aid Study Extension			
Listening Group	Revised Test Questions Only M-1	Revised Test Questions Only M-2	Mean M-1 & M-2	Retention of Skill		Review Technique	
				M-3	M-4	M-1	M-2
S-1	9.00	7.50	8.25	15.75	10.50	13.00	6.75
S-2	9.75	10.25	10.00	2.75	6.00	4.00	3.75
S-3	13.50	8.00	10.75	12.25	10.75	16.75	14.25
S-4	5.50	6.75	6.12	-3.25*	1.00	4.75	1.25
S-5	19.25	14.25	16.75	16.75	15.50	21.75	15.50
S-6	21.00	17.25	19.12	14.75	12.50	20.50	14.25
S-7	21.50	25.50	25.50	18.00	23.00	25.50	23.00
S-8	1.75	5.50	3.62	-2.00*	3.00	1.75	1.75
S-9	10.00	5.50	7.75	8.25	5.50	9.50	8.00
S-10	10.75	17.00	13.88	6.75	9.25	14.25	8.00
Σ	126.00	117.50	121.74	95.25	97.00	131.75	96.50
Mean	12.60	11.75	12.17	9.52	9.70	13.18	9.65
Reading Group							
S-1	13.50	17.50	15.50	17.00	18.25	16.75	15.50
S-2	15.00	15.00	15.00	16.75	15.75	19.25	15.50
S-3	10.75	13.50	12.12	18.00	10.50	16.75	19.25
S-4	20.75	22.00	21.38	14.50	13.00	24.25	18.00
S-5	10.50	14.25	12.38	3.00	3.00	19.25	10.50
S-6	10.50	10.50	10.50	6.75	6.75	15.50	13.00
S-7	10.50	5.50	8.00	14.25	6.75	9.50	9.00
S-8	11.75	18.25	15.00	16.75	13.00	21.75	14.25
S-9	9.25	4.25	6.75	0.00	7.50	16.75	8.00
S-10	7.50	4.25	5.88	4.25	14.25	9.25	9.25
Σ	120.00	125.00	122.51	111.25	108.75	169.00	132.25
Mean	12.00	12.50	12.25	11.12	10.88	16.90	13.22

*For purposes of calculations, counted as 0.00

FINAL REPORT

PART 5

Project No. 5-0801

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FURTHER RESEARCH ON SPEEDED SPEECH AS AN EDUCATIONAL MEDIUM --MATERIALS COMPARISON EXPERIMENTATION

September 1967

U. S. DEPARTMENT OF
HEALTH, EDUCATION, AND WELFARE

Office of Education
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FINAL REPORT

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Further Research on Speeded Speech as an Educational Medium --Materials Comparison Experimentation

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American Institutes for Research
Silver Spring, Maryland

September 1967

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U. S. DEPARTMENT OF
HEALTH, EDUCATION, AND WELFARE

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INTRODUCTION

This is the final report in a series which covers a wide range of experiments concerned with important variables in the comprehension of time-compressed speech. This series was essentially a continuation of a group of experiments completed under an earlier grant (7-48-7670-203) between 1963 and 1965. The main focus of this research has been on the potential application of tape-recorded compressed speech in the college setting as a teaching tool. Two major questions have been asked: How well can college students comprehend connected discourse which has been compressed from normal to as much as three times normal rate? How may that comprehension be improved with practice?

To place this research in proper perspective, it may be advisable to reiterate briefly the background and impetus for compressed speech research. (More detailed reviews appear in earlier progress reports.)

Ever since language has been written it is likely that some people were decoding it faster than the rate at which speech is spoken. Thinking is believed (Nichols, 1955) to proceed at a rate, when it is verbal, which is considerably faster than speech. While it must have occurred to many people that it would be useful to present information orally at a rate faster than normal, there were only two ways in which it could be done. An individual might try to speak faster, but for most people that rate is severely limited. Or, records or tape recordings could be played faster than normal. When that is done, however, the frequency of the sounds of speech are shifted directly upward, and the result is a loss of intelligibility after a certain point.

The vast increase in the amount of information that needs to be communicated in modern times along with developments in information theory has brought with it experiments on the redundancy of speech. An important experiment by Miller and Licklider (1950) demonstrated that an interruption rate of ten or more per second, where the speech is on fifty per cent of the time, does not materially lower the listener's ability to discriminate monosyllabic words. Garvey (1953) took this one step further and physically removed portions of a taped speech record and spliced the remainder together, reasoning that all the elements for intelligibility were there but speech could be presented faster. Then, more or less simultaneously, electronic methods for deleting portions of the speech record and abutting the remainder together were developed by Fairbanks (1954, 1957) in this country and Anton Springer in Germany. Both Garvey and Fairbanks and his colleagues found intelligibility fairly high although much of the speech record was absent. Somewhat later, Bixler, Foulke, Amster and Nolan (1961) applied this new technique of "speech compression" to blind subjects. In 1963, Orr began an investigation of the trainability of listening comprehension under compressed conditions. Research concerned with the variables in improving listening comprehension has been carried on since that time at the American Institutes for Research under grants from the Office of Education.

While the research conducted to date has been concerned with and reasonably successful at improving compressed speech listening comprehension it cannot really be said that a method of training has been achieved. The main reason for this is that so little is known about the training of listening at normal speed, that research results would have been badly confounded if attention was given to training, per se, at high speed. The main approach to answering these questions has taken the following form: Materials suitable for college listening were chosen, edited, recorded and compressed to a variety of speeds. Tests were developed and standardized on a college population. Practice listening material of a lighter nature was recorded and compressed. The experiments were then designed to measure the effects of exposure to compressed speech on the listening comprehension of college freshmen and sophomores. The amount, duration, continuity and rate of the stimulus was varied; listening aids, preparation and instructions have been varied. A number of potentially correlative measures have been taken; and the questions of sex influence, self-pacing of speech rate, and retention of content and skill, have been examined.

In general, the findings have demonstrated that exposure to compressed speech will improve the comprehension of compressed speech.

From a base speed of 175 wpm, the best groups have achieved approximately 90% of normal speed comprehension at 375 wpm, and 80% at 425 wpm. Results have not been uniformly good with all students, however. Retention of content has been at least as good at high speed as at normal speed; i.e., that which is comprehended initially is retained as well over the same period of time. We have not found significant differences between the sexes in compressed speech listening ability. To date no aid to listening, such as the use of a précis or key word list prior to listening, or the presentation of a short tone to highlight important sections during listening, has proved a significant aid to comprehension. Very intensive practice (eight hours a day of high speed listening) has produced effective results in a week, but less efficiently than one and one half hours per day of daily practice. The vast majority of students who have acted as subjects for the experiments have expressed positive attitudes toward compressed speech at the conclusion of the experiments. Most have found the practice listening to be useful in improving their comprehension at high speed, and nearly all the subjects considered compressed speech applicable to some situations in the educational setting.

RESEARCH CONDUCTED SINCE THE PRECEDING REPORT

The remainder of this report concerns research conducted during the six month period since the last Progress Report. It covers the standardization of geology materials and two experiments designed to compare performance on geology and psychology at high speed with each other and performance on the historical materials used in earlier experiments. While the feasibility of using compressed speech for literary and historical material seemed indicated from research to date, no material of more scientific or technical nature had been used in the listening experiments. The more technical material used in the present experiments has a somewhat higher ratio of syllables to words, and slightly longer sentences on the average. While the material chosen is not highly technical in nature (e.g. physics or mathematics) it is sufficiently different from the connected discourse previously used to warrant an examination of its comprehensibility in compressed form.

The Standardization of Geological Test Material

Introduction

During the course of previous experimentation under this and the previous grant, two types of listening materials had been employed: test material which consisted of edited chapters from college level textbooks, one on English history and one on psychology; and practice listening materials from pre-recorded popular novels produced by the American Printing House for the Blind (Talking Books). This material was originally recorded at normal recording speed[1] and then compressed to a variety of speeds ranging from normal (about 165-175 wpm) to approximately 2.7 times normal speed on the Tempo-Regulator. The history material had been the principle material used for investigation. While this material served the purpose well in the determination of the feasibility of measuring and improving comprehension of compressed speech; it remained to be determined whether or not the findings would generalize to different, but equally appropriate material of college level difficulty. For this purpose experiments (described in this report) were done with the psychology material, and a third discipline was selected: physical geology, described below. This area of study was chosen because it represents subject matter which makes use of more technical terms but which does not usually rely heavily on the use of mathematics or visual displays in teaching at the undergraduate level and can fairly be treated as connected discourse. The activities described below concerns the development of standardized tests for listening material in geology.

---

[1] "Normal speed," as we use it throughout this project refers to the speed at which material is recorded by professional readers from a script. This is generally about 175 wpm for historical materials. The material is then compressed such that each passage is approximately equal in the rate at which syllables occur per minute. This principle of measuring rate of speech in syllables per minute is extended to the new materials (geological and psychological) as a more realistic measure. Therefore, while wpm rates of the new material are not necessarily equal to the historical materials, the effective rate is equivalent in syllables per minute.

Method

Subjects: Thirty-nine male students from a local university were employed as subjects for the standardization of the tests on the geology passages. Twenty-six were freshmen, nine were sophomores, and four failed to answer the question about school year on the biographical questionnaire. They ranged in age from 18 to 21 with a mean age of 19. Twenty-eight (72%) of the subjects were born in the Northeastern United States. Only 10.3% of the subjects had spent more than two years in the Washington, D. C., area.

Their major areas of study were as follows: 23% humanities, 15% social sciences, 33% international affairs, and 8% business. The remaining students were undecided. The average letter grade received for the last complete semester was approximately a C+.

Ninety per cent of the subjects had had no training in rapid reading. One subject had heard a single demonstration of compressed speech some months before. All subjects reported having no hearing difficulties and believed their hearing to be approximately the same in both ears.

Subjects were paid approximately $1.50 per hour. Subjects were informed that bonuses based on performance would be paid to the seven best subjects: the best student to receive a $15 bonus; the second best, a $10 bonus; and the remainder, $5 bonuses. None of the subjects had read or looked through the book used in this experiment; and only one subject had ever taken a geology course (and that had been in high school).

Materials: The listening material presented consisted of eleven chapters from a geology textbook - Physical Geology by Don Leet and Sheldon Judson.[2] This is an introductory textbook typical of the kind assigned in a basic geology course. Editing prior to recording was minimal and aimed at making the length and difficulty of the chapters equivalent.

---

[2] Leet, L. Don, and Judson, Sheldon, Physical Geology 3rd Ed., Englewood Cliffs: Prentice Hall, 1965, 406 pp. (Permission granted by publisher).

Since the book was a combined effort of two authors, the characteristics of the material were fairly consistent throughout. Table 1 describes the passage characteristics as they were finally recorded.

Each passage was approximately 3460 words long. There were approximately 166 syllables per hundred words, so that each passage contained about 5750 syllables. The mean number of sentences per passage was approximately 166 with 20.8 words per sentence. Calculations for Reading Ease (according to the Flesch formula) and Listening Grade (according to Rogers formula), were not performed because of the essential inapplicability of such measures to college level technical material.

A comparison of the passages taken from the geology book with those passages previously used from the textbooks on English, history, and psychology shows the following differences:

History passages are approximately 3700 words long, with approximately 144 syllables per hundred words so that each passage contains 5300 syllables. There are about 19 words per sentence.

Psychology passages are approximately 3550 words long, with approximately 165 syllables per hundred words so that each passage contains about 5800 syllables. There are about 21.3 words per sentence.

Probably the most crucial difference between both geology and psychology when compared with history is the syllable to word ratio which is greater for the psychological and geological material. This means, in essence, that there is a greater proportion of multisyllable words used in the geology and psychology passages. To make the speed of presentation comparable to previous material the standard employed was designated in syllables per minute, rather than words per minute (Carroll, 1966).

For each of the recorded passages tests were constructed which contained 45 five-option multiple choice questions. These questions were of the factual, interpretative, and evaluative type. The test booklets were put on stencil and reproduced in the same form used in psychology standardization measures. Separate answer sheets were provided.

Table 1

Characteristics of Passages as Recorded for Use in Research on Speeded Speech as an Educational Medium

	Passage												
	1	2	3	4	5	6	7	8	9	10	11	Mean	SD
Total No. of Words													
History	3803	3515	3780	4039	4049	3320	3350	3550	---	---	---	3676	264.09
Psychology	3473	3631	3600	3589	3546	3467	3561	3525	3461	3638	3633	3556.7	64.84
Geology	3679	3424	3283	3675	3589	3517	3303	3573	3267	3312	3433	3459	30.9
Mean No. Syllables per 100 words													
History	144	137	149	141	148	140	144	149	---	---	---	144	4.18
Psychology	164.2	169.9	160.9	160.5	164.9	169.3	160.1	161.2	169.7	163.4	165.4	164.5	3.58
Geology	172.3	168.6	163.3	170.2	168.9	161.9	161.5	163.8	164.0	165.7	170.2	166.4	3.59
Mean No. of Words per Sentence													
History	18	22	18	18	21	13	20	21	---	---	---	18.8	3.15
Psychology	21.4	20.2	20.2	20.6	24.3	20.2	21.2	19.7	22.0	23.2	21.2	21.3	1.19
Geology	17.8	19.4	19.3	20.1	22.1	20.7	25.6	21.2	22.4	21.2	19.4	20.8	2.34
Total Time for Recording at Normal Speed Recording													
History	21.33	18.30	20.37	20.53	22.00	17.60	18.33	21.37	---	---	---	19.97	1.67
Psychology	21.28	22.33	21.12	22.95	22.50	21.22	21.13	21.70	21.87	23.72	23.08	22.08	.90
Geology	25.37	21.85	21.27	22.93	22.60	21.22	19.35	21.53	19.73	21.05	21.83	21.70	1.58
Mean No. of Syllables per Minute on Normal Speed Recording													
History	252.0	239.8	260.8	246.8	259.0	245.0	252.0	260.8	---	---	---	252.0	8.14
Psychology	268.0	276.3	274.3	251.0	260.0	276.6	269.8	261.9	268.5	250.6	260.4	265.2	8.94
Geology	249.9	264.2	252.1	272.8	268.2	268.4	275.6	271.9	271.6	260.8	268.6	265.8	8.86

In addition to the above materials, biographical data sheets, pay vouchers and a list of debriefing questions at the conclusion of the procedures were presented to all the subjects for completion. Pencils were provided.

The equipment used consisted of a Magnecord tape recorder, amplifier, and speaker with ancillary wiring. The tapes were presented free field in a large classroom with good acoustics.

Procedures: The materials were presented to a large group of subjects at a local university. Subjects were tested as a single group on a Wednesday morning and the following Saturday morning. In the first session, after completion of the biographical questionnaires and the pay vouchers, subjects were told that they would be presented with tape-recorded material taken from a geology textbook to which they were to listen closely, and that tests on each passage would be administered at its conclusion. Subjects were informed of the bonuses to be awarded, and the duration of the experiment.

The first session consisted of seven passages each followed by a test. The second session consisted of the remaining four passages and tests. The material was presented in the same order in which it appeared in the book. Breaks were provided in the middle of each session.

Data Analysis

Responses were key-punched and used in a score test routine which was run on a modified Harvard Graduate School of Education "Multivariate Statistical Analyzer." Each subject item was scored right or wrong. For each item, the item difficulty and the biserial correlation of the item with the total score on the test of which it was a part were calculated. Tallies of option choices for each item were provided. Means, standard deviations, and Kuder-Richardson reliability coefficients, and biserial r's were calculated. After the item selection, the above was rerun for the selected items with the addition of point biserial item-total test correlations.

The following criteria were used in standardizing the tests: Items with item-total score correlations of less than .15 were discarded. Items which were answered correctly by more than 95% of the subjects or less than 15% were discarded. A 60% mean level of difficulty was the goal. Additional items were then discarded with that in mind until the eleven passages had similar median frequency distributions of item difficulties and were consistent with adequate coverage of the material. In achieving this result each test was left with twenty-eight of the original forty-five items (See Progress Report No. 4, Feb., 1967, Table 8 and Apps. B1 and B2).

The newly constituted tests were then typed on stencil and reproduced for use.

Summary

Eleven passages of a length similar to previously used historical and psychological material were selected and recorded from an introductory textbook on geology. These passages were presented at normal speed to a group of 39 college students in two sessions. For each of the passages 45 item multiple choice tests had been constructed and were administered at the conclusion of each playback. Biserial r's, and item difficulty were computed along with overall test reliabilities. The tests were reduced to 28 items each with similar difficulty and reliability characteristics, and characteristics which were similar to the previously used material. This test standardization was done for the purpose of using the new material in a later experiment to compare geological, psychological and historical material with respect to their feasibility for use in compressed speech presentations. The psychology materials used in the experiments reported below were similarly standardized previously (See Progress Report No. 4, February, 1967).

Materials Comparison Experiments

Aim

The Psychology and Geology Materials Comparison Experiments, while conducted separately, were identical in design, and were identical to the design of two previous studies which used historical material. The chief purpose of these studies was to examine the feasibility of using these two types of material as compressed presentations to college students. In order to do this a pattern of practice which proved quite effective in the improvement of comprehension of compressed historical material was repeated. This pattern consisted of practice listening at a single compressed speed for about an hour each day, followed by a presentation of test passage and test, for seven consecutive weekdays. Since this proved effective in the improvement of comprehension of historical material, the question was asked: Will it prove equally effective with psychological and geological material? As reported in this and the preceding Progress Report, material drawn from a textbook in each of these disciplines was selected, edited slightly for greater uniformity of format, recorded, played back at normal speed to a population similar to the ones to be tested, and the performance of those listeners on long multiple choice comprehension tests were analyzed for purposes of standardization of those tests within each discipline. The passages were then compressed and presented in the manner described above to a new group of subjects whose comprehension of the passages was measured by the new revised tests. Since the two experiments were part of the same sequence, the procedures and findings will be discussed jointly.

Procedures (Psychology Materials)

Subjects: Twenty-three male students from a local junior college and university (9 freshmen and 14 sophomores) participated in the experiment. Their ages ranged from 18-22 with a mean age of 19.4 years. All but two of the subjects had lived mostly in Washington, D. C. or in the states immediately surrounding Washington. None had marked regional accents, all spoke English as their native language, and none of the finally selected subjects had marked hearing loss in either ear. Three of the subjects had had training in rapid reading but none had training in rapid listening. Their major subjects represented a cross-section of academic fields and the subjects as a group had maintained a C average in their college course work. Thirteen of the subjects had had at least one course in psychology.

Subjects were tested as a group. They were paid approximately \$1.50 per hour plus \$1.00 per session for carfare. Three bonuses were given: one \$15 bonus, one \$10 bonus, and one \$5 bonus. The subjects were told before the experiment started that bonuses would be awarded on the basis of performance.

Materials: Nine psychological passages were taken from a book on introductory psychology.[3] Six of these passages were compressed[4] from a normal recording speed of approximately 265 spm to 547 spm. (2.09 X normal speed or 337 wpm.) The other 3 passages were used at normal speed (265 spm or 161 wpm). The passages were approximately 3,560 words in length. For each passage a previously standardized five-option multiple choice test of 28 items was used.

Practice material consisted of a "talking book"[5] previously compressed to 375.

Pre- and post-test materials consisted of a biographical data form, debriefing questionnaire and pay voucher.

Equipment used consisted of a Magnecord tape recorder, a Bogen amplifier, two Electro-Voice speakers, ancillary wiring and a pure tone audiometer and head set. The tape recordings were presented free field.

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[3] Miller, George A., Psychology, The Science of Mental Life, New York: Harper & Row, 1962. (Permission granted by publisher).

[4] Throughout this project compression has been accomplished by a German made machine called the tempo-regulator which electronically deletes very minute segments of the record (42 milliseconds) and abuts the remainder together. The size of the discard interval is fixed, a change in the degree of compression is accomplished by the frequency with which the discard segments are removed. The chief advantage of this method is that there is no change of pitch with an increase in speed, nor is the overall intonation pattern altered.

[5] Beach, Edward L., Run Silent, Run Deep, New York: Holt, Rhinehart and Winston, 1955, 364 pp. (Permission granted by publisher).

Procedures (Geology Materials)

Subjects: Twenty male students from a local junior college and university (10 freshmen and 10 sophomores) participated in the experiment. Their ages ranged from 18-23 with a mean age of 19.2 years. All but one of the subjects had lived mostly in the Washington, D. C., metropolitan area. None had marked regional accents, all spoke English as their native language, and none of the finally selected subjects had marked hearing loss in either ear. Three of the subjects had had training in rapid reading but none had had training in rapid listening. Their major subjects represented a cross-section of academic fields and the subjects as a group had maintained a C average in their college course work. Six of the twenty subjects had had at least one course in earth science or geology.

Subjects were tested as a group. They were paid approximately $1.50 per hour plus $1.00 per session for carfare. Three bonuses were given: one $15 bonus, one $10 bonus, and one $5 bonus. The subjects were told at the beginning of the experiment that bonuses would be awarded on the basis of performance.

Materials: Nine geological passages were taken from a college level textbook on physical geology.[6] Six of these passages were compressed (as before) from a normal recording speed of approximately 265 spm to 547 spm. (2.09 X normal speed or 334 wpm.) The other three passages were used at normal speed (265 spm or 160 wpm). All the passages had a mean length of 3,460 words. For each passage a previously standardized five-option multiple choice test of 28 items was used.

Practice material consisted of a "talking book"[7] previously compressed to 375 wpm.

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[6] Leet, Don L. and Judson, Sheldon, Physical Geology, 3rd Ed., Englewood Cliffs: Prentice Hall, Inc., 1965, 406 pp. (Permission granted by publisher).

[7] Beach, Edward L., Run Silent, Run Deep, New York: Holt, Rhinehart, and Winston, 1955, 364 pp. (Permission granted by publisher).

Equipment used consisted of a Magnecord tape recorder, a Bogen amplifier, two Electro-Voice speakers, ancillary wiring and a pure tone audiometer and head set. The tape recordings were presented free field.

Procedural Steps

Each experiment was opened with an introductory statement which described the general nature of the research, its sponsor, and overall aim. A biographical data sheet was completed by all subjects. Periodically during breaks and before and after experimentation, individual subjects were screened for gross auditory defects by means of a pure tone audiometer. The experiment proper was begun, in both cases, with the presentation of the first two passages at normal recording speed. Each was followed by a twenty-eight item multiple choice comprehension test, previously standardized. Two passages were used so that a broader base for the measurement of initial normal speed listening comprehension might be provided. On the next six successive weekdays, the subjects were exposed to 50 minutes of listening to a Talking Book compressed to about 375 wpm from a base of 175 wpm. At the conclusion of practice, a ten minute break was provided. Each day a new passage was presented at about 2.1 times normal speed and the appropriate multiple choice comprehension test given. On the final day an additional passage at normal speed was played at the end of the session. Pay vouchers and debriefing questionnaires were then completed.

The only way in which this procedure differed from that used with the historical materials in two previous experiments was that two, instead of one, normal speed passages were used as initial baseline listening measures to provide a more stable baseline.

In order to make comparisons between scores on tests in different subject matters the data was treated in the following way: the means and standard deviations of the group scores of performance on each passage were computed for all groups. It was then decided to compute a group grand mean and standard deviation for each group based on all scores on all passages over all subjects in the group. All individual groups were then converted into standard scores using the overall group mean and standard deviation. A constant of ten was added to avoid the use of negative figures. This provided essentially the same metric for each group for purposes of performing an analysis of variance. The final passage (at normal speed) was excluded from the standard score computation to avoid confounding practice and speed variables. The data for the subjects who listened to historical material was taken from two previous experiments in which they were controls for the introduction of listening aids in conjunction with compressed speech listening. An analysis of that data did not show significant differences between those two groups (which had identical treatments in the two successive experiments) so that the data were pooled for this analysis.

Findings

The standard score means for each group on successive treatments are displayed in Figure 1 and Table 2. This data can be examined in a number of ways. The overall mean for each group in terms of standard scores is fixed at 10.00. The respective mean scores at initial normal speed for history, psychology and geology were 10.6, 10.4, and 10.9. The best mean performance for each group occurred on the next to the last session with mean scores, respectively, of 10.4, 10.3 and 10.0. At the last session mean performance was about the same for history and psychology groups, but dropped to 9.1 for the geology group.

An analysis of variance was performed on this data. Because of the standardization of the scores within each group there is no difference in overall mean between groups. Significant differences do appear between treatments and in the interaction between treatments and groups. (See Table 3.)

It was anticipated that scores would rise in time with successive treatments; to some extent this has been true of past experiments using the historical material. However, the curve of data with psychology shows a dip in the middle, i.e., a tendency to decrease followed by improvement until performance on the last two tests is approximately equal to normal speed scores. In addition to the standardization of the scores, percentages of normal speed scores were calculated for each of the compressed treatments, as we have done in

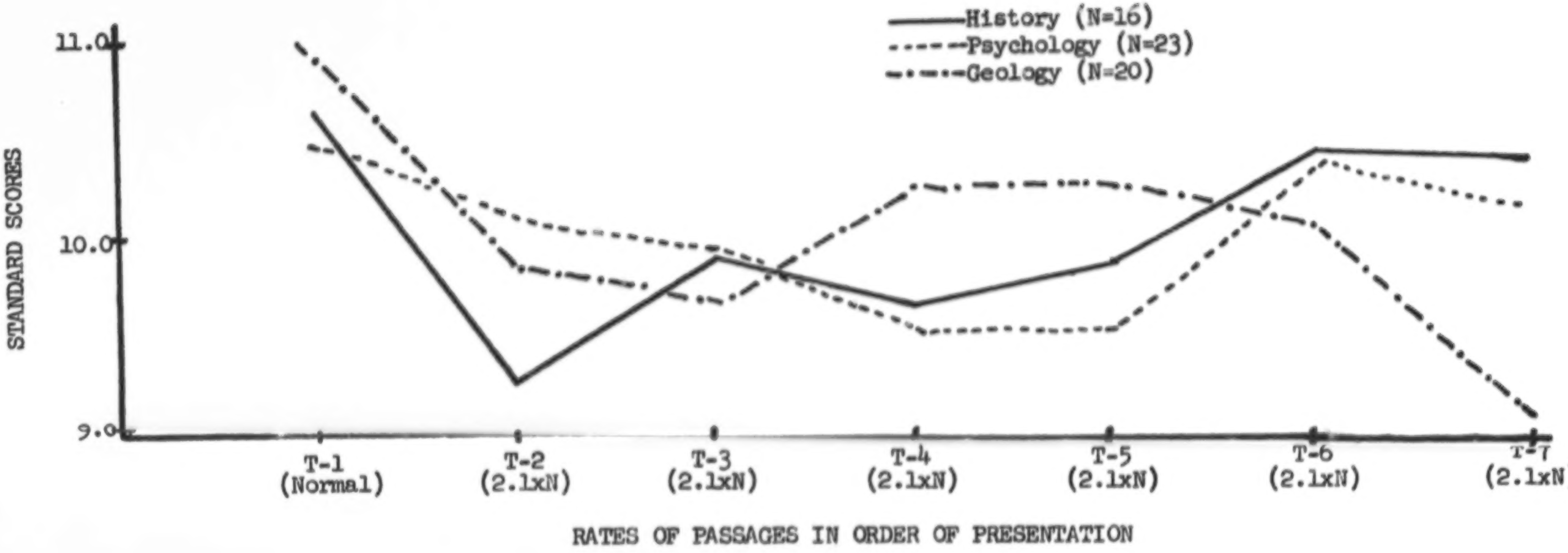

Fig. 1. Curves of listening performance (converted into standard scores) of 59 subjects in three subject matters on successive presentations of compressed speech following normal speed presentation.

Table 2

Mean Listening Test Standard Scores*by Group and Rate of Presentation in Order of Presentation

Subject Group	Rate of Presentation						
			2.09 x N				
	Normal						
History (N=16)	10.58	9.26	9.89	9.63	9.85	10.41	10.39
Psychology (N=23)	10.43	10.08	9.93	9.52	9.54	10.32	10.18
Geology (N=20)	10.88	9.84	9.70	10.21	10.24	10.02	9.12
All Subjects (N=59)	10.62	9.77	9.84	9.78	9.86	10.24	9.88

*The following formula was used to convert scores (See Appendixes A and B) into standard scores: $\text{Standard Score} = \frac{\text{Raw Score - Mean}}{\text{S.D.}} + 10.$

Table 3

Analysis of Variance (Unweighted-Means Solution) for
Unequal Groups of Historical, Psychological and Geological
Compressed Speech Performance

Source of Variation	Computational Formula	SS	df	MS	F
Between subjects			58		
A	$\bar{n}_h[(3') - (1')]$	0	2	0	< 1
Subjects w. groups	(6) - (3)	206.72	56	3.69	
Within subjects			354		
B	$\bar{n}_h[(4') - (1')]$	36.34	6	6.06	15.95 $p < .01$
AB	$\bar{n}_h[(5') - (3') - (4') + (1')]$	39.04	12	3.25	8.55 $p < .01$
B X subjects w. groups	(2) - (5) - (6) + (3)	127.02	336	.38	

previous experiments. The mean percentages and mean raw scores (corrected for chance) appear for all three groups in Table 4. On the last two psychology tests respectively scores were 108 and 97% of normal speed mean scores. The geology data show a fairly solid upward trend until the very last test on which a severe drop in performance occurs. The best group performance on geology was on the next to last session in which the mean score was 91% of normal speed comprehension. The last session mean score is 48%, the lowest group mean score we have ever obtained at this speed.

The inordinately sharp decline in performance on the last of the compressed speech geology passages was unprecedented in that it was the lowest mean performance relative to normal speed performance of any group at that speed at any point in four years of experimentation. Because it occurred at the end of training when, in general, test scores are higher than in the earlier part of training, an artifact of some kind was suspected. A very careful study of possible artifacts has been made including the following: temperature and acoustical conditions in the laboratory on that day of testing by examination of the experimenter's log and debriefing questionnaires which were administered on that day; and potential errors in the scoring key, scoring, tabulation, and statistical analysis. Nothing untoward has been found. The test characteristics when compared with the other tests also show no important differences. This test has a mean difficulty level (when standardized at normal speed) of .650 compared with a mean for all eleven passages of .650; and a mean 'r' of .625 compared with a mean for all passages of .579. It should be noted that these passages were standardized on a similar population at normal speed. In the past we have never found large discrepancies in the relationship between passage difficulty at normal vis-a-vis high speed (which seems to be the case for the other geology passages). However, it is quite possible, and it remains the only likely explanation, that something in the nature of the acoustico-phonetical characteristics of this particular passage changed to a greater extent when it was compressed than did the material in the other geological passages.

A coeffieient of concordance (Kendall's W) was performed on each of the groups to examine the degree to which the listening skill

Table 4

Mean Listening Test Scores and Mean Percentages of Normal Speed Scores by Group and Rate of Presentation in Order of Presentation

Subject Group	Rate of Presentation								
				2.09 x N					
	Norm.	Norm.	Mean						
History (N=16)	14.23			7.67	10.83	9.50	10.61	13.38	13.33
Per cent	100.00	100.00	100.00	52.90	79.15	69.46	75.86	100.36	93.96
Psychology (N=23)	11.45	10.52	10.98	9.48	8.84	7.12	7.26	10.49	9.92
Per cent	100.00	100.00	100.00	98.12	91.02	77.01	74.30	108.04	96.84
Geology (N=20)	18.48	14.69	16.58	11.10	10.40	13.10	13.21	12.06	7.41
Per cent	100.00	100.00	100.00	66.81	66.35	85.90	81.75	91.34	48.00
All Subjects (N=59)	14.58	12.46	13.59	9.54	9.91	9.79	10.18	11.81	10.00
Per cent	100.00	100.00	100.00	75.24	78.70	75.46	76.68	93.87	77.72

manifested in the tests by each subject remains the same relative to other subjects. This proved to be the case for each of the three groups. For history, psychology and geology, the W (coefficient of concordance) were respectively: .644, .565, and .600; all are significant at the $p < .0001$ level.

Debriefing Questionnaire

All twenty-three subjects in the Psychology Materials Comparison experiment and nineteen of the twenty subjects in the Geology Materials Comparison experiment reported that their ability to understand compressed speech improved during the experiment. 55% of the psychology group and 43% of the geology group listed the practice tapes as the most helpful feature. Attitude about the speed of the tapes varied within each group. More than half of the subjects in the psychology group were satisfied with the speed, although 30% thought it too fast. In the geology group 40% of the subjects reported that the speed was about right, 35% thought it a little too fast and 25% said it could have been faster at the end.

Subjects were asked what purposes compressed speech could be used for at the college level. Lectures and reviewing were listed most frequently by the psychology group, while the geology group specified non-technical lectures and added refresher courses. 70% of the psychology subjects and 75% of the geology subjects reported that they would make use of such compressed speech resources.

43% of the psychology group had never had a course in psychology; 22% had had or were taking more than one psychology course. In the geology group only two subjects had ever taken a geology course; five other subjects had taken earth science in high school.

Discussion

The analysis of the data of these two experiments coupled with the previous two on historical materials present certain problems of measurement, which are compounded by the central measurement problem in compressed speech listening research. While intelligibility can be examined with fair precision, comprehension of spoken material presents a more elusive task. It has been dealt with in this project by composing multiple choice questions on the facts and implications in the passages, trying those out on a similar population, and revising the tests so that they will have a moderate level of difficulty, so that the test items will have a high reliability, and so that tests within a given subject matter will be relatively uniform. This provides the experimenter with adequate data for drawing conclusions about comprehension in a given subject matter. When comparing across disciplines the question of comprehension becomes more complex because more variables are involved. Given students of the same general abilities and backgrounds in each of the experiments (an assumption made possible by drawing students on a random basis from the same university at the same age and grade level, and screening for regional accents and gross hearing defects) it still may be asked whether a given subject matter is intrinsically more difficult to comprehend than another. This problem need not be tackled here however. Instead, by constructing tests which have about the same difficulty level (e.g. 60% mean) a comparison is possible.

The tests are based on listening performance at normal speed. It has been assumed with sufficient reason, we think, that the relative difficulty level of the test remains the same, i.e., that the passages whose comprehensibility the tests are designed to measure maintain the same degree of difficulty at high speed vis-a-vis one another. In general, this seems to be the case with the historical passages. It is possible, however, that because of differences in the phonological structure of the passages, a differential change occurs when compression is applied.

Passages within each discipline were chosen and edited to have certain characteristics so that they would be similar to one another. This included the following: the selection of all material within a subject matter from a single book written by one individual, with consequent similarity in syllable to word ratio, style, etc., the editing of the passages so that they would be approximately the same length, and so on. The effect of compression on the passages remains a relatively unexplored area which requires further study.

In general, each of these three subject matters when compressed to more than double their initial speed shows some promise of being useful at that speed. Results on successive treatments vary, however, so that a simple learning curve does not appear. It is quite likely that inherent phonological aspects of the passages play a role in determining their difficulty level when compressed by the currently employed method. It remains the task of the investigators to examine those variables in greater detail.

Psychology and Geology Follow-Up Experimentation

Aim

A brief follow-up to the materials comparison experiment was performed to examine the degree to which retention of skill at listening to compressed speech occurs. In each case all subjects were requested to return for a single experiment held approximately two weeks after completion of the main experiment.

Procedure

Subjects: Seventeen of the original twenty-three psychology subjects and twelve of the original twenty geology subjects were able to return for the follow-up study. The characteristics of these groups were similar to the originals. All had had approximately six hours of practice listening of compressed speech, plus about one hour of test listening.

Materials: Two psychological passages and two geological passages, taken from the same books as the passages used in the original experiments, were used. These tapes were compressed at the same rate as were the tapes in the original experiment. (2.09 x normal speed, 547 spm or 337 wpm.) For each passage a previously standardized five-option multiple choice test of 28 items was used.

Post-test materials consisted of a debriefing questionnaire and pay voucher.

Equipment used consisted of a Magnecord tape recorder, a Bogen amplifier, two Electro-Voice speakers and ancillary wiring. The tape recordings were presented free field.

Procedural steps: For the psychology group the procedures consisted simply of presenting the passages in their order of appearance in the original book, and presenting the standardized multiple choice test after each. The procedure for the geology group was identical.

Design

The two remaining passages in each discipline were presented at the same degree of compression as previously used. Subjects were again informed that there would be a bonus for best performance. Because of the unevenness of the difficulty level of the two tests it was decided to use the mean of both tests as a single score to relate to performance in the experiment proper.

Findings

The tests used for this follow-up section were selected out because they were of somewhat disparate difficulties. It was therefore decided in advance to combine the results of the two tests into a single mean score for each subject. The group mean score for the psychology group was 6.98 compared with a normal speed score (for these subjects) of 10.74, initial compressed of 9.46 and final compressed of 9.91. The geology group showed a mean score of 9.74 on the follow-up, with normal, initial, and final compressed scores respectively of 17.51, 11.88, and 8.52. As noted earlier, the severe drop in performance on the last geology passage remains unexplained by any apparent artifact, but we are not prepared to accept that as a probable result of exposure since it runs contrary to all previous findings in this area. If it is combined with the next to last passage the mean score is approximately 12.01.

The debriefing questionnaire indicated that more than half of the psychology subjects in this follow-up study felt that their comprehension since the end of the last experiment had not changed, while in the case of geology half the group thought that comprehension had worsened; five subjects suggested that there had been no change, and only one thought it had improved. No psychology students had ever seen the text used, and two of the geology students had seen but not studied from the geology text used.

Discussion

The purpose of this follow-up was essentially to measure retention of listening skill two weeks after the end of exposure. In previous experiments we have found a drop in comprehension, but generally after a longer lapse period. In this case we have the surprising result that, not only is there a drop from the later stages of performance, but their scores on the retention material are actually lower than *initial* compressed speech performance. This is significant in the case of the psychology group, from which 17 of the 23 subjects returned, ($p < .02$, $t = 2.88$, 16 d of f); but not in the case of the returning geology students of which there were 12 out of the original 20.

There is no apparent reason why performance after exposure, even after a two-week lapse, should be *worse* than initial exposure to compressed speech in the same subject matter unless motivation flagged. The geology retention group mean scores were in each case higher than mean scores for the overall group, while in the case of the psychology group in each case, but one, the mean scores of the retention group were lower than that of the overall group. While this may suggest that the geology retention group was superior to the original and the psychology retention group inferior, our comparisons are within the retention groups.

We must conclude from this, in so far as the data is reliable, (it should be remembered that only two passages were employed and rather small groups, especially in the case of geology) that the motivation of the group as a whole was not what it was at the start of the main experiment.

SUMMARY

The research described in this report is the last of a sequence of experiments begun two years ago (which followed an earlier grant) in which variables associated with the comprehension of compressed speech in an educational setting have been examined. The technique used for compression involves the electronic deletion of very minute segments of a tape recording while joining the remainder together thereby shortening the overall duration. This is accomplished without change in the pitch of the speech record or seriously altering the overall intonational patterns.

The studies in this report describe the preparation of listening and test materials in geology at the college level, and the examination of listening performance with this material, with previously prepared psychological material, and with performance on historical materials previously used in this research. With the exception of an unexplained setback on the final geology test, performance relative to normal speed in listening to compressed materials in psychology and geology is not worse than in history over a similar training period of approximately ten hours spread over a week. Retention of listening skill, which was tested for these subject matters confirms earlier findings under diverse conditions which suggest that the listening skill usually built up during experimental exposure, is not retained if no intervening training is given.

OVERVIEW OF COMPRESSED SPEECH RESEARCH--1963-1967

Under two grants of the new Educational Media branch of the U. S. Office of Education research has been conducted at the American Institutes for Research since 1963 in which a large number of variables have been examined in compressed speech listening. At the risk of being overly redundant, we feel that a brief recapitulation of that research may serve a useful purpose here.

The overall purpose of this research has been to determine the feasibility of using the fairly new technique of speech compression to present lecture and textbook materials to college students. The complexity of speech, not to mention the educational situation itself, present a formidable array of known and unknown variables from which a researcher must select those he feels can be most profitably examined. Taking as guidelines the availability of technical and educational resources, the limitations of time and money, and the issues we felt were most germane to the problem at hand, we examined the following major questions. They have loosely been placed in three categories: stimulus, situational, and listener variables. The superscripts refer to Table 5 in which are listed the individual experiments and the reports in which they are described.

Stimulus Variables

Amount, duration, rate, content and continuity of exposure to practice and test listening materials have been examined. We have found that approximately ten hours of exposure, of which two-thirds is of lighter material (novels) spread over a period of approximately one week is sufficient to achieve normal comprehension at approximately double speed for most students.[12,13] Ten to fifteen hours of exposure is sufficient to achieve approximately 80% of normal comprehension at two and one half normal speed (425 wpm).[4] Listening to the practice materials for approximately an hour without interruption presents no difficulty.[12,13,19] Thirty-five hours of exposure in a week's time offers no advantage in training, and some disadvantages.[7] Rest period of three minutes after each ten minutes of exposure is no better and possibly detrimental to the achievement of good comprehension than an

Table 5

Major Experiments Conducted at the American Institutes for Research since 1963 in Factors Associated with the Use of Speeded Speech as an Educational Medium

Title of Experiment	AIR Project Designation	Report	Date of Report
1. Exploratory Study	D-50	Progress Report # II	December 1963
2. Paced Reading Study	D-50	Project Report	June 1964
3. Standardization of History Test Materials	D-50	Project Report	June 1964
4. Graduated Practice	D-50	Project Report	June 1964
5. Male vs. Female Interrupted Practice	D-50	Project Report	February 1965
6. Concentrated (high-speed) Practice	E-50	Progress Report # 1	July 1965
7. Immersion Study	E-50	Progress Report # 2	January 1966
8. Criterion Studies I & II	E-50	Progress Report # 2	January 1966
9. Retention Study I	E-50	Progress Report # 2	January 1966
10. Retention Study II	E-50	Progress Report # 2	January 1966
11. Retention Study III	E-50	Progress Report # 2	January 1966
12. Listening Aid Study I	E-50	Progress Report # 3	July 1966
13. Listening Aid Study II	E-50	Progress Report # 4	February 1967
14. Self-Pacing Study	E-50	Progress Report # 4	February 1967
15. Standardization of Psychology Test Materials	E-50	Progress Report # 4	February 1967
16. Use of Compressed Speech as a Review Technique	E-50	Progress Report # 4	February 1967
17. Listening Aid Study II Extension	E-50	Progress Report # 4	February 1967
18. Standardization of Geology Test Materials	E-50	Final Report	September 1967
9. Materials Comparison Experiments	E-50	Final Report	September 1967
0. Materials Comparison Follow-Up Studies	E-50	Final Report	September 1967

uninterrupted flow.[5] The use of incremental increase in rate over this period from about one and one third faster than normal to two and one half is not any better or worse than presenting all material at two and one half normal from the beginning.[4,6] As noted earlier in this report, we have established most of these findings by using novels as practice listening material,[7] and historical passages as test materials.[3] We have now examined psychological[15] and geological[18] materials as well, and while we have much less data in these areas, our results suggest that both of these disciplines may be amenable to compressed presentation.[19]

Situational Variables

Under this broad heading we have included the use of listening aids before and during material presentation, self-determination of rate, the measurement of retention, and the use of compressed speech as a method of review. We have found that neither the use of carefully prepared written summaries of material to be heard,[12,13] scrutinizing a list of key words to appear in the passage,[12] nor the presentation of a short tone during the passage to highlight significant portions[13] have altered performance relative to control groups without any of those listening aids, when speech is presented at better than double speed. (In each of these experiments, however, we have reconfirmed the basic finding that virtually normal listening performance at those speeds can be achieved.) In several experiments under a variety of different conditions we have measured both retention of listening skill and retention of material originally heard at compressed speeds. In most cases we have found the skill to disappear rapidly,[10,11,12] although we have not tested the possibility that retraining may be effected more easily. Retention of content, however, is at least as good as normal speed content. In the single study in which subjects manipulated the rate of presentation themselves we found no differences in either the rate selected or the listening scores.[14] We feel, however, that self-pacing deserves examination in conditions of greater exposure and an opportunity to become comfortable with the technique. We have found in the past that repetition of passages, not surprisingly, leads to improvement in comprehension.[6,8] The likelihood of using compressed speech to review material already familiar is a logical step from this. The pilot study performed as an adjunct to another study did not confirm this;[16] but there again we feel that further experimentation focusing on this problem is in order.

Listener Variables

Increasingly as the research progressed and the ability of groups of college students to learn to comprehend compressed speech in a relatively short time was confirmed and reconfirmed, we began to turn our attention to individual differences. We found no difference between male and female students in this respect.[5] We have found intercorrelations between listening and reading scores generally positive.[5,6] There is no overwhelming evidence, however, that normal speed listening scores correlate significantly with high speed listening scores. We have found a suggestion that while general language handling abilities correlate positively with compressed speech listening performance, skill at giving attention to detail in language does not.[12] We have never found a significant group mean improvement in either normal speed listening or reading skills relative to control groups at the conclusion of compressed speech experimental exposure. We have found significant reading improvement in several experimental and control groups,[4,5,6] but it should be borne in mind that the control groups also had some regular exposures to the test materials in compressed form.

Throughout our research we have presented debriefing questionnaires at the end of each major experiment designed to get subjective reactions from our students. The vast majority of students have responded positively to the question of whether they would like to see compressed speech used in some form in their college curricula. Nearly all subjects also expressed the belief that practice listening skill improved their comprehension of compressed material. Overall we have experienced both a willingness to participate in our experiments, and a degree of enthusiasm for the potential use of compressed speech in education which has been most encouraging.

THE FUTURE OF COMPRESSED SPEECH

At the time research in this subject was begun at the American Institutes for Research there were just a handful of people who had been or were then engaged in research in this area. Since that time impetus for new research has been provided not only by experimental findings but by dissemination to the public and professional community by means of a national television broadcast (December 1965), a symposium on compressed speech (annual convention of the American Psychological Association, September 1965), and the first Louisville Conference on compressed speech (October 1966) which led to the establishment of the Center for Rate Controlled Recordings. Research interest is now spreading rapidly as is the demand for information about its potential use.

In considering future activities in the compressed speech realm we have, somewhat arbitrarily, divided it into four categories: 1. The presentation of information at variable rates; 2. The use of compressed speech as a training device to improve language comprehension; 3. The measurement of aptitude in the isolation of speed listening factors; and 4. The use of compressed speech as a unique research tool which can alter the temporal variable in speech while holding other factors essentially constant.

We are currently continuing our research in two of these areas. The first is an examination of factors in the use of compressed speech for teaching purposes. Continued support of the U. S. Office of Education has enabled us to begin an examination in depth of individual differences in listening behavior under compressed conditions, including a basic attack on certain fundamental listening behaviors, and studies of varied methods of preparation and presentation of compressed speech material.

In a second project just under way we are examining the potential of rate controlled speech (including expanded speech) in second language learning, and the selective perception of stimulus material in an effort to examine mediating variables in listening and responding to second language.

In both these and other projects which we hope will be undertaken there are two aspects of the research which we fell will demand more and more attention: 1. What are the basic listening processes underlying the comprehension of speech? 2. What are the practical applications of compressed speech in the burgeoning world of communication? We trust our confidence is shared that research in these areas will lead to the advancement of the state of knowledge in education and communication to the benefit of all.

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Appendix A

PSYCHOLOGY MATERIALS COMPARISON EXPERIMENT

Scores Corrected for Chance

Passages and Rate of Presentation

Subjects	M-1 Norm.	M-2 Norm.	M-1& M-2 Mean	M-3 2.09 x N	M-4 2.09 x N	M-5 2.09 x N	M-6 2.09 x N	M-7 2.09 x N	M-8 2.09 x N	M-9 Norm.	M-10 2.09 x N	M-11 2.09 x N	M-10 & M-11 Mean
A-1	10.00	16.25	13.12	11.50	9.00	9.25	12.00	15.75	16.25	20.25	8.75	8.75	8.75
A-2	15.75	13.00	14.38	10.50	14.25	8.00	9.25	13.00	13.00	14.25	----	----	----
A-3	4.50	1.00	2.75	5.75	6.75	7.00	5.75	11.75	3.00	14.25	----	----	----
A-4	16.50	18.00	17.25	5.75	4.75	8.50	*-1.50	11.75	9.25	14.25	----	----	----
A-5	9.25	5.50	7.38	4.25	6.75	5.50	3.00	5.50	5.50	.50	1.75	3.00	2.38
A-6	7.00	8.00	7.50	4.25	2.75	3.00	7.25	5.50	5.00	12.25	6.25	2.00	4.03
A-7	18.00	20.50	19.25	14.25	14.25	8.00	15.75	13.00	14.25	18.00	11.75	10.50	11.13
A-8	9.00	13.00	11.00	9.50	10.25	3.00	9.25	13.00	15.00	11.25	9.25	10.25	8.75
A-9	7.75	10.50	9.12	15.00	4.75	6.75	5.25	4.75	4.75	5.00	13.50	7.50	10.50
A-10	9.00	7.50	8.25	7.00	5.25	1.50	7.25	7.25	7.75	*-1.25	*-1.50	1.75	.12
A-11	11.00	8.50	9.75	9.25	8.00	2.00	6.75	9.25	4.25	13.00	4.25	10.50	7.38
A-12	14.50	1.75	8.12	5.50	6.75	6.75	4.25	.50	11.75	.75	1.75	*-.75	.50
A-13	11.00	5.50	8.25	8.00	10.50	5.50	9.25	14.25	6.00	10.50	----	----	----
A-14	5.75	11.75	8.75	11.75	9.25	15.50	8.00	14.25	13.00	9.25	----	----	----
A-15	23.00	14.25	18.62	15.50	18.00	10.50	10.50	19.25	15.50	20.50	----	----	----
A-16	6.50	8.25	7.38	15.25	11.00	14.25	7.75	12.50	11.50	9.25	6.75	6.75	6.75
A-17	9.00	7.75	8.38	8.75	7.75	9.00	5.75	12.50	9.25	11.75	9.75	7.25	8.95
A-18	8.00	.75	4.38	8.75	6.00	4.50	3.00	2.00	8.00	5.50	.50	*-.75	*-.12
A-19	13.75	11.25	12.50	10.00	18.25	5.75	10.75	18.00	14.25	18.25	12.00	16.00	14.00
A-20	11.75	13.00	12.38	8.75	5.50	3.50	7.00	9.50	9.25	7.50	5.50	3.00	4.25
A-21	13.25	10.25	11.75	6.00	14.00	10.00	4.25	3.25	11.25	6.50	9.50	5.50	7.50
A-22	14.75	18.50	16.62	13.50	4.50	7.00	6.50	12.50	11.00	14.50	6.75	14.75	10.75
A-23	14.25	17.25	15.75	9.25	5.00	9.00	8.50	12.25	9.50	14.50	13.50	8.25	10.88
E	263.25	242.00	252.63	218.00	203.25	163.75	167.00	241.25	228.25	251.75	121.50	115.75	118.63
$\bar{X}$	11.45	10.52	10.98	9.48	8.84	7.12	7.26	10.49	9.92	10.95	7.15	6.81	6.98
S.D.	4.33	5.43	4.34	3.42	4.26	3.46	3.29	4.87	3.84	5.82	4.27	4.63	4.45
N=23													N=17
Retention Group Mean Scores (N=17)													
E	186.75	178.50	182.63	160.75	139.75	108.75	124.25	157.00	168.50	168.75			
$\bar{X}$	10.99	10.50	10.74	9.46	8.22	6.40	7.31	9.24	9.91	9.93			
S.D.	3.15	5.34	3.77	3.40	4.02	3.24	3.20	4.87	3.64	6.11			

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*In calculations, score considered as 0.00.

Appendix B

GEOLOGY MATERIALS COMPARISON EXPERIMENT

Scores Corrected for Chance

	Passages and Rate of Presentation												
Subjects	L-1 Norm.	L-2 Norm.	L-1 & L-2 Mean	L-3 2.09 x N	L-4 2.09 x N	L-5 2.09 x N	L-6 2.09 x N	L-7 2.09 x N	L-8 2.09 x N	L-11 Norm.	L-9 2.09 x N	L-10 2.09 x N	L-9 & L-10 Mean
A-1	25.50	20.50	23.00	13.25	16.75	18.00	18.00	16.75	16.25	20.75	19.50	12.25	15.88
A-2	17.00	5.25	11.12	2.00	10.50	12.75	12.50	14.50	7.50	18.00	4.50	10.75	7.62
A-3	17.75	18.75	18.25	17.00	15.00	21.50	18.75	15.25	6.00	17.50	15.75	15.75	15.75
A-4	20.50	15.25	17.88	12.50	9.75	17.50	10.75	11.75	7.25	21.25	11.50	14.75	13.12
A-5	9.25	11.75	10.50	10.75	10.75	5.75	9.75	9.25	3.00	9.75	11.25	6.00	8.62
A-6	23.25	15.00	19.12	10.50	10.50	14.25	13.25	16.00	1.25	16.75	5.75	9.00	7.38
A-7	14.50	11.75	13.12	7.25	6.75	5.75	11.75	3.25	*-2.00	12.50	----	----	----
A-8	13.75	14.75	14.25	10.25	10.75	4.25	8.00	9.50	4.75	16.75	----	----	----
A-9	15.50	18.25	16.88	10.50	14.50	12.75	18.75	11.50	4.75	17.00	----	----	----
A-10	25.50	20.50	23.00	23.25	11.00	14.50	21.75	19.75	16.00	20.50	10.75	11.00	10.88
A-11	20.50	23.00	21.75	10.50	9.25	13.00	11.75	10.50	8.00	14.25	5.25	7.50	6.38
A-12	17.00	16.75	16.88	11.00	9.25	20.50	19.50	18.25	14.25	15.25	2.75	10.50	6.62
A-13	24.50	17.25	20.88	12.25	11.00	15.00	16.00	6.00	9.25	19.50	----	----	----
A-14	12.25	15.00	13.62	9.00	5.25	13.00	4.00	13.75	4.75	12.25	11.25	9.25	10.25
A-15	21.75	9.25	15.50	8.00	8.00	14.25	4.25	5.50	11.75	3.00	----	----	----
A-16	19.25	14.25	16.75	11.50	11.75	17.00	13.75	14.75	13.25	14.75	----	----	----
A-17	22.00	15.75	18.88	13.50	13.50	12.50	17.50	23.25	8.75	15.00	6.25	6.50	6.38
A-18	16.25	16.00	16.12	9.25	8.50	17.25	12.75	17.00	9.25	16.00	3.75	12.25	8.00
A-19	16.75	6.75	11.75	6.75	8.50	7.00	8.50	3.00	.50	7.00	----	----	----
A-20	16.75	8.00	12.38	13.00	6.75	5.50	13.00	1.75	1.75	6.75	----	----	----
E	369.50	293.75	331.63	222.00	208.00	262.00	264.25	241.25	148.25	294.50	108.25	125.50	116.88
X̄	18.48	14.69	16.58	11.10	10.40	13.10	13.21	12.06	7.41	14.72	9.02	10.46	9.74
S.D.	4.32	4.60	3.74	4.10	2.83	4.96	4.81	5.81	4.88	4.84	4.95	2.90	3.33
N=20													N=12

Retention Group Mean Scores (N=12)

	L-1 Norm.	L-2 Norm.	L-1 & L-2 Mean	L-3 2.09 x N	L-4 2.09 x N	L-5 2.09 x N	L-6 2.09 x N	L-7 2.09 x N	L-8 2.09 x N	L-11 Norm.
E	226.75	193.50	210.12	142.50	130.00	180.50	170.25	186.00	102.25	197.25
X̄	18.90	16.12	17.51	11.88	10.83	15.04	14.19	15.50	8.52	16.44
S.D.	4.99	6.28	4.17	5.04	3.05	4.25	3.25	3.95	4.18	3.47

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*In calculations, score considered as 0.00.

Appendix C

PSYCHOLOGY MATERIALS COMPARISON EXPERIMENT

Percentages of Normal Scores* Corrected for Chance

	Passages							
Subjects	M-3 2.09 x N	M-4 2.09 x N	M-5 2.09 x N	M-6 2.09 x N	M-7 2.09 x N	M-8 2.09 x N	M-9 Norm.	M-10 & M-11 Mean 2.09 x N
A-1	87.65	68.60	70.50	91.46	120.05	123.86	154.34	66.69
A-2	73.02	99.10	55.63	64.33	90.40	90.40	99.10	----
A-3	209.09	245.45	254.55	209.09	427.27	109.09	518.18	----
A-4	33.33	27.54	49.28	00.00	68.12	53.62	82.61	----
A-5	57.59	91.46	74.53	40.65	74.53	74.53	6.78	32.25
A-6	56.67	36.67	40.00	96.67	73.33	66.67	163.33	54.93
A-7	74.03	74.03	41.56	81.82	67.53	74.03	93.51	57.77
A-8	86.36	93.18	27.27	84.09	118.18	136.36	102.27	88.64
A-9	164.47	52.08	74.01	57.57	52.08	52.08	54.82	115.13
A-10	84.85	63.64	18.18	87.88	87.88	93.94	00.00	10.67
A-11	94.87	82.05	20.51	69.23	94.87	43.59	133.33	75.69
A-12	67.73	83.13	83.13	52.34	6.16	144.70	9.24	10.84
A-13	96.97	127.27	66.67	112.12	172.73	72.73	127.27	----
A-14	134.29	105.71	177.14	91.43	162.86	148.57	105.71	----
A-15	83.24	96.67	56.39	56.39	103.38	83.24	110.10	----
A-16	206.64	149.05	193.09	105.01	169.38	155.83	125.34	91.46
A-17	104.42	92.48	107.40	68.62	149.16	110.38	140.21	101.43
A-18	199.77	136.99	102.74	68.49	45.66	182.65	125.57	5.71
A-19	80.00	146.00	46.00	86.00	144.00	114.00	146.00	112.00
A-20	70.68	44.43	28.27	56.54	76.74	74.72	60.58	34.33
A-21	51.06	119.15	85.11	36.17	27.66	95.74	55.32	63.83
A-22	81.23	27.08	42.12	39.11	75.21	66.19	87.24	64.68
A-23	58.73	31.75	57.14	53.97	77.78	60.32	92.06	69.08
E	2256.69	2093.51	1771.22	1708.98	2484.96	2227.24	2592.91	1055.13
$\bar{X}$	98.12	91.02	77.01	74.30	108.04	96.84	112.74	62.07
S.D.	50.30	49.87	58.48	38.48	82.41	37.51	99.59	34.34
N=23								N=17
			Retention Group Mean Scores (N=17)					
E	1626.75	1391.77	1111.56	1175.62	1460.20	1669.59	1549.94	
$\bar{X}$	95.69	81.87	65.39	69.15	85.89	98.21	91.17	
S.D.	48.01	38.57	43.03	21.17	43.33	39.85	52.78	

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*The mean score of passages M-1 and M-2 presented initially at normal speed is taken as the baseline of 100%.

Appendix D

GEOLOGY MATERIALS COMPARISON EXPERIMENT

Percentages of Normal Scores* Corrected for Chance

	Passages							
Subjects	L-3 2.09 x N	L-4 2.09 x N	L-5 2.09 x N	L-6 2.09 x N	L-7 2.09 x N	L-8 2.09 x N	L-11 Norm.	L-9 & L-10 Mean 2.09 x N
A-1	57.61	72.83	78.26	78.26	72.83	70.65	90.22	69.04
A-2	17.99	94.42	114.66	112.41	130.40	67.45	161.87	68.53
A-3	93.15	82.19	117.81	102.74	83.56	32.88	95.89	86.30
A-4	69.91	54.53	97.87	60.12	65.72	40.55	118.85	73.38
A-5	102.38	102.38	54.76	92.86	88.10	28.57	92.86	82.10
A-6	54.92	54.92	74.53	69.30	83.68	6.54	87.60	38.60
A-7	55.26	51.45	43.83	89.56	24.77	00.00	95.27	----
A-8	71.93	75.44	29.82	56.14	66.67	33.33	117.54	----
A-9	62.20	85.90	75.53	111.08	68.13	28.14	100.71	----
A-10	101.09	47.83	63.04	94.57	85.87	69.57	89.13	47.30
A-11	48.28	42.53	59.77	54.02	48.28	36.78	65.52	29.33
A-12	65.17	54.80	121.45	115.52	108.12	84.42	90.34	39.22
A-13	58.67	52.68	71.84	76.63	28.74	44.30	93.39	----
A-14	66.08	38.55	95.45	29.37	100.95	34.88	89.94	75.26
A-15	51.61	51.61	91.94	27.42	35.48	75.81	19.35	----
A-16	68.66	70.15	101.49	82.09	88.06	79.10	88.06	----
A-17	71.50	71.50	66.21	92.69	123.15	46.35	79.45	33.79
A-18	57.38	52.73	107.01	79.09	105.46	57.38	99.26	49.63
A-19	57.45	72.34	59.57	72.34	25.53	4.26	59.57	----
A-20	105.01	54.52	44.43	105.01	14.14	14.14	54.52	----
E	1336.25	1283.30	1569.27	1601.22	1447.64	855.10	1789.34	692.48
$\overline{X}$	66.81	64.16	78.46	80.06	72.38	42.76	89.47	57.71
S.D.	20.82	17.57	26.50	25.35	33.92	25.78	28.03	19.29
N=20								N=12
			Retention Group Mean Scores (N=12)					
E	805.46	769.21	1030.82	980.95	1096.12	576.00	1160.93	
$\overline{X}$	67.12	66.35	85.90	81.75	91.34	48.00	96.74	
S.D.	23.76	20.49	30.11	25.38	23.59	22.27	23.93	

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*The mean score of passages L-1 and L-2 presented initially at normal speed is taken as the baseline of 100%.